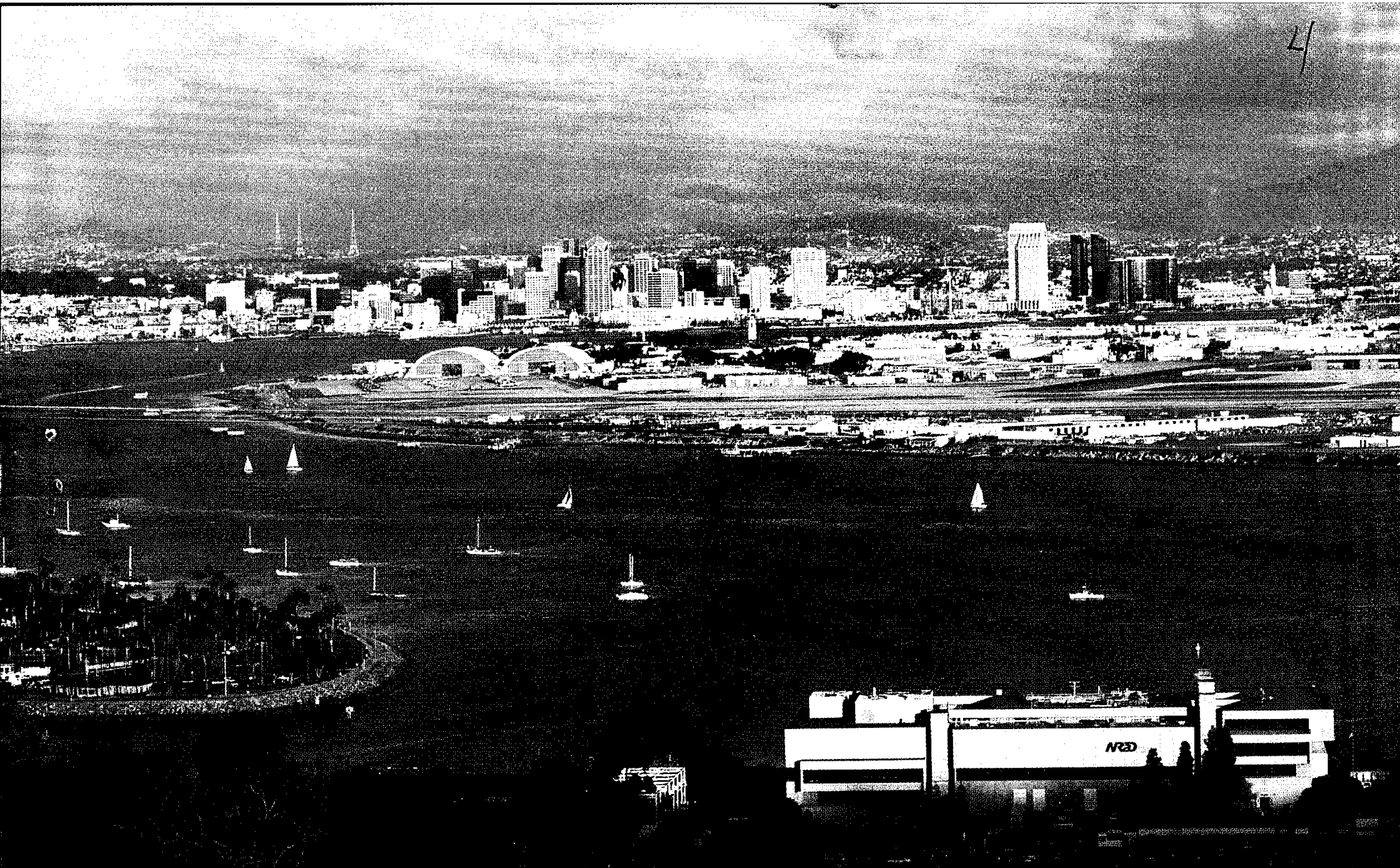

Command History
Calendar Year 1994

Technical Document 2735
June 1995

Naval Command, Control and
Ocean Surveillance Center
RDT&E Division

San Diego, CA
92152-5001

Technical Document 2735
June 1995

Command History

Calendar Year 1994

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NAVAL COMMAND, CONTROL AND OCEAN SURVEILLANCE CENTER RDT&E DIVISION
San Diego, California 92152–5001

K. E. EVANS, CAPT, USN
Commanding Officer

R. T. SHEARER
Executive Director

ADMINISTRATIVE INFORMATION

This technical document was prepared in response to OPNAVINST 5750.12E. The document summarizes the major activities and achievements of the Naval Command, Control and Ocean Surveillance Center's RDT&E Division in 1994.

This document was prepared by the Technical Information Division using in-house funding.

Released by
E. R. Ratliff, Head
Publications Branch

Under authority of
M. E. Cathcart, Head
Technical Information
Division

CONTENTS

Appendices

PREFACE

The Naval Command, Control and Ocean Surveillance Center, RDT&E Division, or NRaD, Command History for calendar year (CY) 94 is submitted in conformance with OPNAVINST 5750.12E. The history provides a permanent record of CY 94 activities at NRaD. Although the history covers one calendar year, certain information was available on only a fiscal year (FY) basis and is so noted in the text.

The history is divided into two main parts: (1) administrative developments and (2) technical developments. The first section gives an introduction to NRaD and describes developments in finance, organization, personnel, and facilities. The second section documents technical programs underway during 1994. Programs are organized by department.

Because the results of scientific work often develop out of many years' effort, programs are not always documented annually. Previous command histories provide extensive background articles on many major programs. When possible, background articles are prepared for new or previously untreated programs. By consulting command histories written over a period of several years, a reader can follow the broad thrusts of Division research and development.

Appendices to the history provide supplementary information to the main text. Appendix A lists achievement awards given in CY 94. Appendix B lists patents awarded in FY 94. Appendices C and D provide lists of distinguished visitors hosted by NRaD and major conferences and meetings at NRaD, respectively.

While acronyms and abbreviations are defined when first used in the text, a glossary is included for reference.

ADMINISTRATIVE DEVELOPMENTS

INTRODUCTION TO NCCOSC RDT&E DIVISION

The Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division (or NRaD) is a full–spectrum RDT&E laboratory serving the Navy, Marine Corps, and other Department of Defense and national sponsors within its mission, leadership assignments, and prescribed functions. NCCOSC is one of the Navy's four major warfare centers and reports directly to the Commander, Space and Naval Warfare Systems Command (SPAWAR) in Washington, DC. At NRaD we provide solutions to Navy, joint service, and national problems by generating and applying science and technology. We provide innovative alternatives to tomorrow's decision makers, enabling them to pursue new or expanded missions and capabilities.

We work closely with NCCOSC inservice engineering divisions to provide Fleet, joint, and national users and customers with complete life–cycle support. This support spans efforts that range from generating science and applying technology to creating new system concepts and upgrading older systems to perform previously unforeseen roles. We also work with SPAWAR, other Navy system commands, the Office of the Chief of Naval Operations, the Fleet, the Office of Naval Research, defense and national agencies, academia, and industry to produce quality products and services. Our roles include providing leadership for developing systems and solutions and functioning as a "smart buyer" to ensure that the government purchases quality products in an increasingly complex and technological marketplace.

At NRaD, we are strongly committed to our customers. We maintain close contact with them to ensure that our efforts remain relevant and meet the needs and threats of tomorrow; our goal is to ensure that Navy, joint commands, and defense and national agencies—the ultimate users and customers of our products—retain technological and operational superiority. We are also uniquely capable of serving operational users during national crises. Specifically, we support systems that we have helped introduce into today's forces by providing technical expertise and laboratory and test facilities not available to operational commands.

We continue to serve our sponsors in roles for which we have demonstrated expertise: management of Technology Blocks, creation and demonstration of technology, program formulation and initiation, Technical Direction Agent, Acquisition Executive Agent, Software Support Agent, system and subsystem prototyping, and the support of test and evaluation. We also actively license technology and support the transition of technology to industry.

NCCOSC and its RDT&E Division were created as part of the Base Realignment and Closure Act of 1991. NRaD was created from several predecessor organizations including the Naval Ocean Systems Center, the Communications and Navigation Technology Department of the Naval Air Development Center, the Navy Space Systems Activity, and the Fleet Fleet Combat Direction Systems Support Activity.

Mission

NRaD's mission is to be the Navy's research, development, test and evaluation center for command, control and communication systems and ocean surveillance and the integration of those systems which overarch multiplatforms.

Leadership Assignments

NRaD leadership assignments are as follows:

Command, control, and communication systems
Command, control, and communication systems countermeasures
Ocean surveillance systems
Command, control, and communication modeling and analysis
Ocean engineering
Navigation support
Marine mammals
Integration of space communication and surveillance systems

Warminster Detachment

The NRaD Warminster detachment performs navigation support and communications functions.

FINANCE

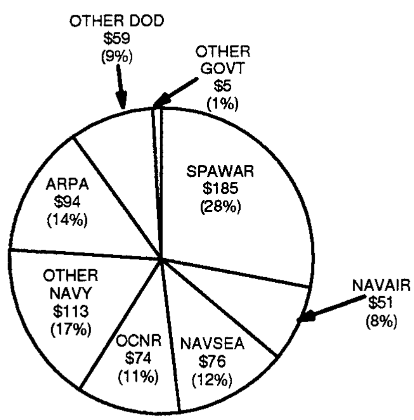
NRaD receives funding from sponsors that include SPAWAR, the Naval Sea Systems Command (NAVSEA), the Naval Air Systems Command (NAVAIR), and the Office of the Chief of Naval Research (OCNR). The accompanying chart shows funding by sponsor for FY 1994.

In FY 94, NRaD received new orders totaling $657 million, an increase of $47 million from the $704 million received in FY 93.

FUNDING BY SPONSOR

FY 1994

ACTUAL $657*



*Includes Direct Cites $207 million

SPAWAR	–	SPACE AND NAVAL WARFARE SYSTEMS COMMAND
NAVAIR	–	NAVAL AIR SYSTEMS COMMAND
NAVSEA	–	NAVAL SEA SYSTEMS COMMAND
OCNR	–	OFFICE OF THE CHIEF OF NAVAL RESEARCH
ARPA	–	ADVANCED RESEARCH PROJECTS AGENCY

Direct Cites – Requests for Contractual Procurement (RCPs) and Military Interdepartmental Purchase Requests (MIPRs). Financed directly by sponsor rather than NRaD NIF account.

ORGANIZATION

NRaD is organized into five technical departments and several staff codes. The five technical departments include Navigation and Air C^3, Command and Control, Marine Sciences and Technology, Surveillance, and Communications.

The following chart reflects NRaD organization as of 30 September 1994.

PERSONNEL

Total personnel as of 30 September 1994 was 2879, including 95 military and 2782 civilians. Further personnel data are given in the chart.

PERSONNEL DATA

TOTAL ON BOARD	TOTAL MILITARY	TOTAL CIVILIANS	FTP[1]	TPTI[2]	FTP UNGRADED
2879	95	2782	2746	8	28

FTP GRADED

2746

ADMINISTRATIVE	242
TECHNICIANS	248
SCIENTISTS AND ENGINEERS	1618
TECHNICAL SPECIALISTS	282
CLERICAL	356

[1]Full-time, permanent civilian personnel

[2]Temporary, part-time, intermittent civilian personnel subject to manage-to-payroll (MTP) controls.

FTP GRADED SCIENTISTS AND ENGINEERS

ELECTRONICS ENGINEERS	819
PHYSICISTS	164
MECHANICAL ENGINEERS	112
MATHEMATICIANS	99
GENERAL ENGINEERS	66
OCEANOGRAPHERS	16
OPERATIONS RESEARCH ANALYSTS	61
COMPUTER SCIENTISTS	163
PSYCHOLOGISTS	32
CHEMISTS	9
OTHER	77
TOTAL	1618

FACILITIES

NRaD occupies more than 507 acres of land on the Point Loma peninsula, approximately 7 miles from downtown San Diego. Facilities are concentrated in three major areas: Topside, Bayside, and Seaside.

NRaD Topside, located on the ridge of Point Loma, includes the principal administrative and support sections, as well as facilities for communications, environmental testing, electronic materials, advanced electronics, laser technology, and ocean surveillance.

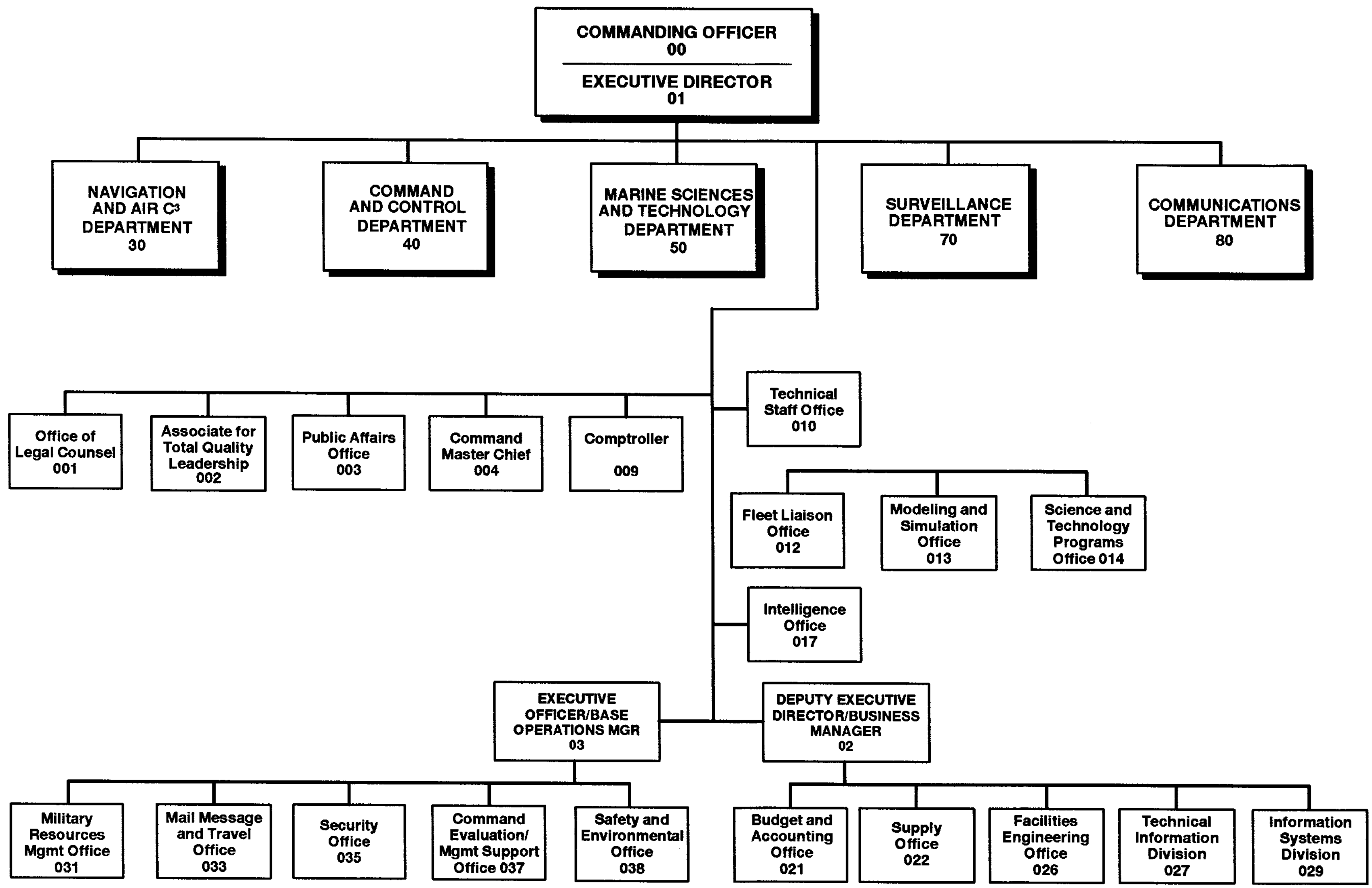
NRaD Bayside faces San Diego Bay, which provides the waterfront access and berthing capabilities vital to NRaD activities in ocean surveillance

and marine sciences. McLean Laboratory and the Ocean Sciences Laboratory are located Bayside.

NRaD Seaside, located on the west slope of Point Loma, offers a protected, electromagnetically shielded site essential to RDT&E in command, control, communications, and intelligence (C^3I) and ocean surveillance.

Additional facilities include a detachment in Warminster PA; sea ranges at San Clemente; and a field station at La Posta, CA.

NCCOSC RDT&E DIVISION ORGANIZATION

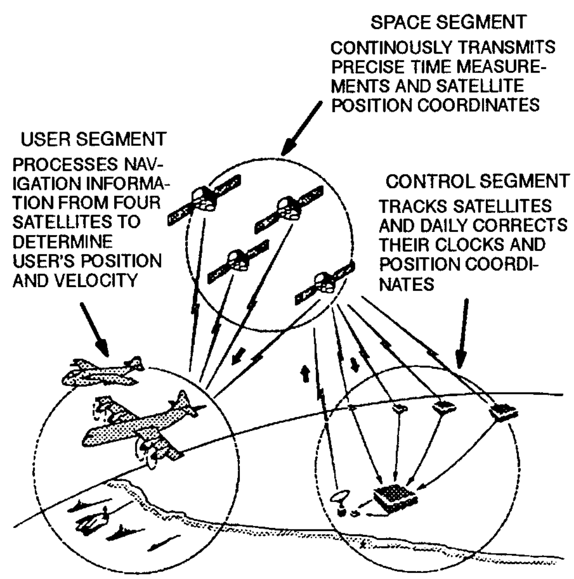


TECHNICAL DEVELOPMENTS

NAVIGATION AND AIR C3 DEPARTMENT

GLOBAL POSITIONING SYSTEM (GPS)

The NAVSTAR Global Positioning System (GPS) is a space-based radio navigation and positioning system that will provide extremely accurate three-dimensional position and velocity information as well as precise time to suitably equipped users worldwide. GPS consists of three major segments: space, control, and user equipment.



NAVSTAR GPS program segments.

GPS will provide worldwide precision navigation and time to U.S. military forces and their allies. Military forces are required to know their position in order to enhance command and control, coordinate battle tactics and support, engage in strategic and tactical warfare, maneuver efficiently on the battlefield and at sea, provide accurate and timely fire support, and facilitate combat support operations. In addition, knowledge of exact positions and time is essential for reconnaissance and intelligence missions. A worldwide positioning and navigation system can increase both accuracy and availability of current weapon systems, thus increasing their effectiveness and acting as a force enhancement.

The GPS Program is a multiservice effort, as directed by the Department of Defense. The Air Force has been designated the executive service for program development. NCCOSC's RDT&E Division Detachment serves as the technical and field staff of the Navy GPS Program Office, providing both the Navy Deputy at the Joint Program Office and a significant portion of technical expertise in the development of the GPS User Equipment. The Detachment maintains simulation and modeling capability for equipment validation/certification, SSA test, and accuracy and error analysis in both basic and differential operations.

GPS/Electrically Suspended Gyro Navigator (ESGN)

Program accomplishments during CY 93 included the following:

Completed installation, checkout, and training on a Pacific Fleet SSN 637 Class Fast Attack Submarine at Mare Island Shipyard in Vallejo, CA. This installation consisted of the addition of GPS/ESGN and GPS/ precise time interfaces to the existing AN/WRN-6 configuration on board.

AN/WRN-6 Equipment Suite

Program accomplishments in CY 94 included the following:

Delivered, installed, and verified operation of a keyed AN/WRN-6 receiver to Research Vessel RV Knorr in support of Woods Hole Oceanographic Institute project in Jacksonville, FL.

Successfully installed AN/WRN-6 equipment suites aboard four amphibious ships, in support of

the AN/KSQ-1 (PLARS) DT IIA testing for the Naval Surface Warfare Center Coastal Systems Station, Panama City, FL. Provided technical support of large-scale, at-sea amphibious exercises to validate operation and usability. Trained ships' force personnel in the operation and maintenance of the GPS user equipment. The installation, complicated at-sea amphibious exercises, and deinstallation were successfully carried out in a very brief time window.

Precision Lightweight GPS Receiver (PLGR)

Program accomplishments during CY 94 included the following:

Received the first shipment of PLGRs for fleet distribution.

Global Positioning System Interface Unit (GPSIU)

The Global Positioning System Interface Unit (GPSIU) integrates GPS latitude and longitude information into the Position Locating and Reporting System (PLARS) for use within the AN/KSQ-1 Amphibious Assault Direction System. The GPSIU was designed in-house and will enable GPS navigation information to be distributed to the PLARS.

Program accomplishments in CY 94 included the following:

Participated in a major 1-month Navy and Marine amphibious assault exercise at Camp Pendleton, CA to aid in installing and testing the NRaD-developed GPSIUs. The GPSIU integrates GPS latitude and longitude information into the PLARS for use within the AN/KSQ-1 Amphibious Assault Direction System. Results showed that the GPSIU enhanced the performance of the PLARS significantly.

Standoff Land Attack Missile (SLAM) GPS

Program accomplishments during CY 94 included the following:

Installed an NRaD-developed SLAM GPS initialization system aboard USS *George Washington* (CVN 73) in Norfolk, VA. Trained ship's personnel on the proper operation of the system. Nearly every carrier has had one of these systems installed.

SURFACE SHIP RING LASER GYRO NAVIGATOR (RLGN)

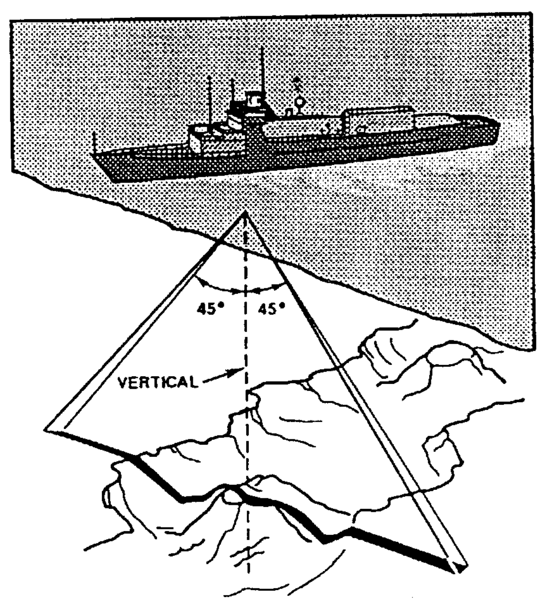
The Ring Laser Gyro Navigator (RLGN) is the next-generation inertial navigation system under development for surface ships. NRaD is responsible for development and transition of the RLGN into the Fleet and for subsequent product improvements. NRaD also provides an extended performance capability, a significantly improved reliability, and a much lower life-cycle cost.

Program accomplishments during CY 94 included the following:

Completed development of a RLGN system specification for U.S. Navy submarine and surface combatant platform applications.

OCEAN SURVEY PROGRAM (OSP)

NCCOSC's RDT&E Division Detachment is the technical agent for the Naval Oceanographic Office with total responsibility for the design, development, test, and evaluation of the complete shipboard mission equipment for the Ocean Survey Program (OSP). The mission survey system is a highly complex, integrated navigation, bathymetric, and data refinement system that produces



Ocean survey program (OSP).

high-accuracy charts of bathymetry, gravity, magnetics, and other geophysical parameters in support of the Trident Fleet Ballistic Missile Submarine Program. The system is operational on four deep-ocean survey ships: the USNS *Maury* (T-AGS 39), USNS *Tanner* (T-AGS 40), USNS *H. H. Hess* (T-AGS 38), and USNS *Wyman* (T-AGS 34).

The OSP has a BRICKBAT 01 priority, the Navy's highest, and is in a continuous evolutionary phase to maintain the highest state-of-the-art in survey capability and productivity. The program is providing new challenges in ocean bottom characterization, shallow-water coastal surveys, and bistatic bathymetry to meet future requirements.

A 4500-square-foot Systems Integration Laboratory (SIL) supports in-house OSP hardware and software development. Three major laboratory areas are in operation for bathymetric refinement, multibeam sonar, and navigation system development.

In CY 94, NRaD successfully completed the second and final at-sea TECHEVAL of the major Ocean Survey System upgrade aboard the USNS *Wyman*. This upgrade increases survey system capability and provides NAVOCEANO with their first multimission-capable survey platform.

The upgrade was designed and developed to improve the operability, productivity, reliability, and maintainability of the on board system. The system collects data and produces accurate charts of bathymetry, gravity, and other oceanographic parameters for use by the fleet.

The upgrade includes changes to both the system hardware and software. Aged computers and associated peripherals were replaced with state-of-the-art computers and workstations.

The upgrade includes a new Mission Control and Processing Subsystem (MCAPS). This consists of three workstation systems to improve both real-time and post-time data analysis and processing capabilities for central control of the system computers.

The MCAPS has a new Survey Control System (SCS) three-monitor workstation that permits the system operator to remotely control the navigation and wide swath multibeam sonar programs. The SCS also has new and improved displays facilitating efficient survey management.

The new System Analysis Station (SAS) is also part of the MCAPS. This two monitor workstation has displays for on-line system performance analysis and control of the system plotter functions.

The DRS has more efficient and flexible post-time data analysis and processing than was possible with the older Bathymetric Replacement System that produces the final shipboard data products.

The wide swath multibeam sonar system has an improved shallow-water capability that allows recording of depths to 20 fathoms. The previous minimum usable depth was 100 fathoms. The cross track coverage of the multibeam sonar was also increased from 90 to 120 degrees for depths of less than 2500 fathoms, decreasing to 90 degrees for deeper depths.

A new Backscatter System operates in parallel with the wide swath sonar receivers. It records the acoustic data from the sonar receivers for post-time generation of high-resolution images on the ocean bottom.

The system upgrade includes various other improvements including:

a. An upgraded Ship Attitude Data Converter (SADC) that receives attitude data in synchro form from various sensors and distributes the data in synchro and digital format. The SADC also provides simulated dynamic attitude data to support system testing when the ship is dockside.

b. An upgraded Current Profiler System (CPS) has improved operability capabilities. The CPS develops a velocity profile of the water currents beneath the ship and measures the ship's velocity.

c. An upgraded Narrow Beam Sonar System provides improved performance for the single

beam sonar system utilizing a new programmable transceiver and digital signal processor.

d. An upgraded Sound Velocity System has improved operability and automatic transfer of sound velocity data to the multibeam sonar system.

e. Upgraded navigation system software offers improved operability and eliminates the need for hard copy outputs.

f. A new 60-Hz and 400-Hz regulated and uninterruptible power system is required to support the system upgrade.

NAVIGATION SENSOR SYSTEM INTERFACE (NAVSSI)

The Navigation Sensor System Interface (NAVSSI) is designed to integrate shipboard navigation sensors and systems and to provide a single best source of navigation information to all users. NRaD is responsible for development and preplanned product improvement of the NAVSSI including incorporation of ship navigation planning aids, digital nautical charts, plotting capabilities, addition of navigation sources and users, and accuracy improvements.

Program accomplishments during CY 94 included the following:

Completed development of a NAVSSI module to allow NAVSSI availability at any Navy Tactical Control System-Afloat (NTCS-A) terminal. This is a major step required to fully integrate the NAVSSI into the Joint Maritime Command Information System (JMCIS) program.

NAVSSI Surface Ship Block 0. Received Milestone IIIa approval. Thirty-five systems are now scheduled for procurement and installation on cruisers and destroyers.

CONTROL DISPLAY NAVIGATION UNIT (CDNU)

Program accomplishments in CY 94 included the following:

Control Display Navigation Unit (CDNU) Software Build. Successfully tested CDNU software build 1 for the UH-1N helicopter in the NRaD CDNU development and test facility.

DATA REFINEMENT SYSTEM

Program accomplishments in CY 94 included the following:

Data Refinement System (DRS) Installation and Testing. Completed the installation and testing of a DRS at the United Kingdom Hydrographic Office in Taunton, England. In addition, NRaD provided training to UK personnel on operation of the system. The DRS will be used by the UK Hydrographic Office to refine the bathymetric data that will be collected and preprocessed on board the UK Ocean Survey Vessel that will be equipped with the bathymetric survey system developed by NRaD Warminster.

COMMAND AND CONTROL DEPARTMENT

ADVANCED COMBAT DIRECTION SYSTEM (ACDS)

The Advanced Combat Direction System (ACDS) is a major development program that will upgrade the current Navy Tactical Data System (NTDS) on aircraft carriers, LHDs, and selected cruisers. ACDS is being developed in two phases designated as Block 0 and Block 1. ACDS Block 0 is intended to provide for the installation of upgraded Navy-standard computers, displays, and peripheral hardware, and the rehosting and enhancement of existing Model 4 NTDS software to operate on this hardware. ACDS Block 1 is planned to provide a major software upgrade to Model 5 NTDS by using the same hardware as installed for Block 0. In addition to the Model 5 capability, principal software enhancements provided by the Block 1 computer program include increased surveillance ranges and capacities, automation of the track management process, integration of electronic surveillance measures (ESM) and nonorganic surveillance assets, enhanced ability to identify system tracks based on contributing sensor sources, improved multiship gridlock achieved in concert with JTIDS, and system adaptability through operator-defined doctrine processes.

Program accomplishments in CY 94 included the following:

ACDS Block 0 Level 8 Deliveries. Delivered the ACDS Block 0 Level 8 to USS *Essex* (LHD 2), USS *Abraham Lincoln* (CVN 72), USS *George Washington* (CVN 73), USS *Dwight D. Eisenhower* (CVN 69), USS *Carl Vinson* (CVN 70), USS *Theodore Roosevelt* (CVN 71), USS *Wasp* (LHD 1), USS *Constellation* (CV 64), USS *Independence* (CV 62), USS *America* (CV 66), and the Fleet Combat Training Center Atlantic (FCTCLANT).

ACDS Shipboard Integration Tests. Conducted the ACDS Block 0 Level 8 program Shipboard Integration Tests on USS *Constellation* (CV 64). The Block 0 program will be used to validate shipyard hardware installations and Inspection and Survey (INSURV).

ACDS Block 0 Level 9. Delivered Block 0 version C90D program tapes to Atlantic Fleet Weapons Test Facility (AFWTF), Puerto Rico; AFWTF received target allocations and OPEVAL was successfully conducted.

ACDS Block 1. Installed and demonstrated ACDS Block 1 aboard USS *Constellation* (CV 64).

ACDS Support. Participated in ongoing C^4I grooming onboard USS *Carl Vinson* (CVN 70) in Alameda, CA, and provided shipboard and battle force support of at-sea operations; provided ACDS support of the Block 0 program and provided Block 1 crew training onboard USS *Constellation* (CV 64) (efforts included installation of a VAX workstation and the first successful load of an ACDS Block 1 program); and provided Cooperative Engagement Capability (CEC) training onboard USS *Dwight D. Eisenhower* (CVN 69).

USS Constellation CO Cites NRaD Efforts. "As 'America's flagship' arrives in WESTPAC on her first deployment in nearly 7 years, we leave behind a C^4I support team that has become part of our crew. 'Connie' could not have progressed to her present high level of readiness without the support of these professionals." Thus stated the letter of appreciation addressed to Code 40 personnel from USS *Constellation* (CV 64) Commanding Officer Capt. Gil Rud.

The message referenced the devoted and tireless efforts of the Command and Control Department, Code 40, that Capt. Rud termed the "most extensive combat direction center installation in

history." Code 40 personnel delivered the ACDS, the Command and Control Processor, a state-of-the-art Combat Direction Center (CDC) command table, color large-screen display, map server, the Combat Simulation System, and a multiple emulation capability.

ACDS integrates the ship's sensors, weapons, and intelligence sources to allow command and control of battle group tactical operations.

A significant accomplishment was demonstration of ACDS Block 1 Level 0, the first "productionized" version of ACDS Block 1. The first full production version of ACDS Block 1 is the Level 1 version. It is scheduled for formal delivery in January 1996 after completing certification for use in operational environments. This version will incorporate changes from lessons learned during the demonstration.

During the demonstrations, a higher capacity of ACDS Block 1 over earlier ACDS systems was apparent. During one at-sea evaluation near the Los Angeles/Orange County area, ACDS Block 1 was tracking three times the number of targets ever tracked by a shipboard combat direction system.

Key "firsts" demonstrated included a 4000 by 4000 mile theater-sized surveillance coverage, the ability to track and display significantly higher numbers of tracks, and the first full implementation of the Tactical Digital Information Link-J (TADIL-J) message capability on a surface ship. TADIL-J affords significantly higher resolution of track identification and support of advanced electronic warfare capabilities. Other "firsts" were display of track symbology in color and the use of artificial intelligence features that continuously analyze the tactical situation providing heightened awareness to the crew. Also demonstrated were the Navy fully TADIL-J capable command and control units that allow the *Constellation* and an E-2C aircraft to communicate using the Joint Tactical Information Distribution System/TADIL-J.

Training on the new advanced technology systems was part of the overall ACDS Block 1 demonstration transition effort. Personnel from NRaD Code 40 and Hughes Aircraft Corporation developed and executed an ACDS Block 1 training program for the crew. Formal classroom and mockup training was provided to crewmen in the ACDS laboratories of Buildings C60 and 600. Material developed for these training sessions and reviews of the training by crew members is being incorporated into the full curriculum developed for ACDS by Code 56 personnel.

A large-screen display was installed using a ruggedized color large-screen display projector. This was a joint Code 44/industry effort to develop a shock- and vibration-certified version of a commercial color large- screen display system.

A digital map server, developed by Code 44, was installed to show ACDS operators full-color world vector shoreline, airway, and country boundary maps with overlaid tract symbology.

The existing CDC command table was replaced with a new version developed by Code 43 that incorporates advanced video and keyboard switching capabilities to control ACDS displays. Several Navy Tactical Command System-Afloat subsystem displays and ship's television displays at color monitors on the command table and on three large-screen displays were installed.

A multiplatform emulator device system (MPEDS) replaced militarized peripherals in ACDS. MPEDS, designed by Code 43, was implemented using commercial technology including emulator replacements for the AN/UYH-3 disk, the RD-358 magnetic tape unit, the AN/USQ-69 data terminal set and an AN/UYA-4/OJ-194 display console. These successful demonstrations led to installation of these four technology transition systems.

Color display capabilities were added to already installed ACDS operator consoles. Code 43 and Hughes Aircraft personnel modified the AN/UYQ-21/OJ-535 consoles to provide high-resolution color displays at six operator workstations.

Code 43 also installed improved training capabilities with the ACDS Combat Simulation System, a real-time simulation system used in development laboratories for ACDS software debug and testing. The scenario generation and playback

capabilities will support a significantly more robust training for the combat direction center crew.

Deployed in the Western Pacific with the *Constellation*, the ACDS Block 0 program continues to support shipboard command and control operations using a regenerated set of software improvements based on the previous Model 4 Naval Tactical Data System.

HIGHLY DYNAMIC AIRCRAFT (HyDy)

The objective of the Highly Dynamic (HyDy) Vehicles in a Real and Synthetic Environment program is to enable real high-speed objects to interact on a virtual battlefield. NRaD is the Technical Direction Agent; the sponsor is the Advanced Research Projects Agency (ARPA).

HyDy Demonstration. In CY 94, NRaD successfully tested the ground portion of HyDy, which comprises real and synthetic targets being displayed at an F-14D Radar Intercept Officer (RIC) position. The test demonstrated the ability to take Tactical Air Combat Training Systems (TACTS) messages and translate that information to interact with Distributed Interactive Simulation (DIS) Protocol Data Unit (PDU) compliant simulators.

COMMAND AND CONTROL PROCESSOR (C^2P)

The Command and Control Processor (C^2P) is intended for use aboard major combatants (carriers and cruisers) to provide tactical data link service to the ship's Combat Direction System (CDS). The C^2P provides the ship's CDS data link service on Link-11, Link-4A, and the new TADIL-J/Link-16.

The C^2P is being developed in two configurations. One of the configurations, termed "(V0)," is intended to allow the introduction of the Joint Tactical Information Distribution System (JTIDS)/ Link-16 into ships with "Model 4" CDSs. The second version of C^2P, termed "(V1)," is intended to provide full TADIL J/Link-16 service on the ships scheduled to receive the new "Model 5" ACDS Block 1 CDS.

NRaD is the Technical Direction Agent (TDA) for the C^2P and is leading the government acceptance test and product validation effort. NRaD is also the designated Software Support Activity (SSA) for the system.

Program accomplishments in CY 94 included the following:

Link-16 Test. Conducted a successful Link-16 test using Model 5 C^2P and the ACDS Block 1 programs; this was the first test using the JTIDS Link-16 and the Model 5 C^2P system on USS *Constellation* (CV 64).

TECHEVAL. Successfully completed TECHEVAL.

C^2P Deliveries. Completed the following C^2P deliveries: the Model 5 version to USS *Constellation* (CV 64); Model 4 version to USS *Abraham Lincoln* (CVN 72); and the Model 4 Low-Level NTDS Serial Interface version to the AEGIS Test Facility at Wallops Island.

JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS)

The Joint Tactical Information Distribution System (JTIDS) is a high-capacity communications terminal that will provide aircraft and ship platforms with secure, jam-resistant voice and data communications.

Program accomplishments in CY 94 included the following:

JTIDS Data Terminal Device (DTD) and Key Management System (KMS). Conducted and successfully completed the Government Acceptance Test (GAT) for the JTIDS DTD and PC KMS.

JTIDS Demonstration at Pentagon. Successfully completed three separate JTIDS Link-16 demonstrations from the SOCAL area to the Pentagon via satellite. The satellite communications link was used as a gateway to provide both a real-time tactical display of the *Vinson* Battle Group and slow-motion video images from the periscope of the submarine USS *Asheville* (SSN 758).

JTIDS Stand-Alone Antenna. Passed all environmental and high-power tests for shipboard use of the AS-4400/URC JTIDS Stand-Alone Antenna.

The Stand-Alone Antenna is designed for installations that do not need a TACAN capability and to provide a receive-only backup capability on board platforms with the larger AS-4127 URC-107(V) JTIDS Antenna. Authorization was received to install the JTIDS Stand-Alone Antenna (military designation applied for) to replace existing three-antenna configurations aboard the DDG 72 on up class ships, and identification, friend or foe (IFF) antennas on all new ships. This antenna is planned for use with the AS-4127 JTIDS antenna in a receive-only mode to provide additional receive coverage, resolving multipath problems.

JTIDS AND C^2P OPEVAL

"Operationally effective and suitable. All critical operational issues have been satisfied. No deficiencies."

These were the conclusions of the Commander, Operational Test and Evaluation Force on the performance of JTIDS and the C^2P. Operational evaluation (OPEVAL) of JTIDS and the C^2P were conducted during the USS *Carl Vinson* Battle Group deployment to the Persian Gulf and transit of the Pacific and Indian Oceans.

This important step in the introduction of JTIDS and C^2P into the fleet was the culmination of years of development work by Navy activities and supporting contractors, including many key players from NRaD.

JTIDS is a time-division multiple-access communication system providing secure, jam-resistant digital data and voice communication for command and control, navigation, relative positioning, and identification of surface ship, aircraft, submarine and land-based units. JTIDS has operated at line-of-sight ranges over 300 nautical miles and, with automatic relay between JTIDS units, at relay ranges up to 1200 nautical miles.

The primary function of JTIDS within the Navy is to distribute secure digital tactical and voice information to users and to locate and identify JTIDS participants with great precision. Spread-spectrum techniques make JTIDS resistant to jamming, and data encryption makes it secure. JTIDS can handle large amounts of data, far more than other communications systems now used for similar purposes. JTIDS is a key component of a new communications architecture to facilitate tactical decision-making and timely allocation of resources in response to fleet requirements well into the 21st century.

Tactical digital information links (TADILs) represent a system concept including the equipment, protocols, and standards designed to provide for exchange of tactical information and control of assets. TADILs as used in the Fleet today principally involve an incrementally upgraded 1958 design. With the introduction of JTIDS, the requirement for faster response to commands and the reporting of fast- moving attacking targets have been seriously addressed. New operating systems in the host combat system computers, in conjunction with JTIDS data link, provide a new capability that gives the Fleet a tactical command and control system with rapid response, accuracy, and timeliness critical to survival. These new systems such as the ACDS and the avionics of the F-14D, E-2C, F-15 and E-3A aircraft, are the hosts implementing the TADIL-J message standard, the associated system, and operator protocols. Data exchange with units having the older TADIL-A message standard (Link-11) is achieved by translation in the C^2P. The TADIL-J message standard set, the JTIDS data link, and the implementation of TADIL-J in host systems is referred to as Link-16.

JTIDS is a major defense acquisition administered through a joint program office (JPO) located at Hanscom Air Force Base, MA. The Navy JTIDS program is managed by the Advanced Tactical Data Link Office, Program Executive Officer—Space, Communications and Sensors (PEOSCS). PEOSCS is responsible for acquisition of Navy JTIDS terminals via the JPO, integration of JTIDS on all Navy platforms, and implementation of the TADIL-J message standard.

NCCOSC is the primary field activity responsible for implementing and testing the JTIDS and C^2P programs within the Navy and for providing in-service JTIDS and C^2P engineering support.

NCCOSC also provides fleet system engineering for new JTIDS terminal communication networks, other Link-16 developments, and major modifications that are developed, tested, and integrated into platforms by NRaD. NRaD provides a wide variety of Link-16 test facilities, including the unique multiterminal System Integration Facility (SIF). The SIF is capable of testing JTIDS terminals and local and remotely located host systems, using NRaD-developed gateway techniques operating in a realistic multiterminal environment.

Link-16 software for host platforms is developed and maintained by Software Support Activities (SSAs) within NRaD. This "cradle-to-grave" concept instills sensitivity to fleet concerns into software developers and eliminates the inefficiencies of transferring software to separate SSA organizations for life-cycle maintenance.

The Link Project Office (LPO) was established by PMW 159 at the NCCOSC In-Service Engineering West Coast (NISE West) Division to provide a single point of contact for the Fleet for all Link-16 matters. The LPO includes representatives from research and development, SSA, and the In-Service Engineering communities. The LPO works with PMW 159 to ensure operability and ensure all aspects of the Link-16 program are appropriately supported during implementation in diverse Navy platforms.

Direct fleet support for the Navy JTIDS terminal and the C^2P is provided by the In-Service Engineering Agent (ISEA) within NISE West. The ISEA coordinates with other Navy shore commands to provide on-board support to the Fleet and ensure that the requisite technical support is provided in an effective and timely manner.

The C^2P Subsystem. The C^2P subsystem provides the capability of integrating the new Link 16 aboard major surface combatants.

The C^2P is hosted in the United States Navy standard mainframe computer AN/UYK-43B. The C^2P provides for interfacing the ship's combat direction system to the TADILs in a manner that allows for own ship to concurrently participate on any combination of either Link-11, Link-4A, or the new Link-16.

In addition to providing for initialization and control of Link-16, the C^2P provides each ship with the capability of concurrently controlling aircraft on both Link-4A and Link-16.

Probably the most complex capability to be accomplished by the C^2P is to implement a data-forwarding function between the Link-11 and Link-16 communities within the operational force. The data-forwarding function requires that all messages received on either Link-11 or Link-16 be translated and forwarded or transmitted to the opposite link.

Code 40 and its predecessor organizations have been responsible for the design and development of the C^2P from initial concept through the recent successful completion of OPEVAL.

Code 45 is continuing NRaD involvement with the C^2P as the designated software life cycle support activity.

NAVY TACTICAL COMMAND SYSTEM-AFLOAT (NTCS-A)

The Navy Tactical Command System-Afloat (NTCS-A) is the primary Navy command and control system afloat. NTCS-A integrates the functional capabilities of several command, control, communications, and intelligence (C^3I) systems into a single system that supports C^3I requirements for both unit-level and flag-level commanders.

The objective of the NTCS-A program is to develop and field an integrated, automated command and control system for the support of afloat naval commanders, i.e., officer in tactical command (OTC), composite warfare commander (CWC), and commanding officer (CO). This system will provide the ability to receive, process, display, and manipulate data in near realtime on the readiness and warfighting capabilities of friendly (U.S. and allied) forces in support of the full range of Navy missions.

Program accomplishments in CY 94 included the following:

NTCS-A/JMCIS 2.1 Build. Completed integration and test facility setup and management preparations for production of the USS *Dwight D. Eisenhower* (CVN 64) JMCIS 2.1 build. JMCIS 2.1 will ultimately include all NTCS-A applications plus Operation Support System (OSS) applications.

NTCS-A/2.0.10.5 Installation. Completed (with NISE East and West) USS *Constellation* (CV 64) 2.0.10.5 installation. The NTCS-A team loaded software and conducted certification testing of the SCI system, helped solve remaining hardware problems, and provided parts to complete the installation. NRaD also installed software, tested the hardware, and conducted certification tests on the stand-alone SCI Correlator. This is the first shipboard installation of a system that will allow retirement of the HP 9020-based Advanced Tracker Prototype.

NTCS-A/JDISS Certification. Supported the Office of Naval Intelligence in the certification of the Joint Deployable Intelligence Support System (JDISS) as a segment on the Joint Maritime Command Information System (JMCIS) 2.1 software. This will be installed first on USS *Dwight D. Eisenhower* (CVN 64) in JMCIS Phase 3. This JDISS segment moves JDISS functionality from a separate integration program that will merge JDISS databases ashore with JMCIS databases afloat.

NTCS-A/CTAPS Servers and TACs. Completed installation of six Contingency Theater Air Control System Automated Planning System (CTAPS) servers and three TACs on USS *Kitty Hawk* (CV 63). The software was configured for WESTPAC and all six communication paths were verified operational.

MAP GENERATOR PROTOTYPE

The NRaD Map Generator Prototype is a transition effort of the ONT block-funded Map Generator program. The system will overlay digital maps, air corridors, and other graphic objects on the existing OJ-535 tactical situation displays.

The Map Generator provides high-resolution World Vector Shoreline maps and Digital Aeronautical Flight Information File (air corridors) as color graphical underlays to tactical situation displays on six UYQ-21 consoles, one PT-525 monochrome large-screen display, and the new Ampro color large-screen display.

In CY 94, NRaD installed, tested, and evaluated the Map Generator Prototype and the Ampro 2600 color large-screen display on the USS *Constellation* (CV 64).

TEMPO BRAVE SUPPORT

NRaD provided extensive support of the USCINCPAC Gaming and Simulation Facility (GSF) during exercise Tempo Brave.

AGGREGATE LEVEL SIMULATION PROTOCOL (ALSP)

NRaD completed certification testing of Research, Evaluation, and Systems Analysis (RESA) and MAGTF Tactical Warfare Simulation (MTWS) at the Warrior Preparation Center Germany for the ALSP Confederation of Models to be used in future Joint and Allied Computer-Aided Exercises. RESA is certified as a fully interactive member of the confederation. MTWS is certified to receive ALSP objects.

BRIGADE/BATTALION BATTLE SIMULATION (BBS)

The objective of the BBS program is to deaggregate constructive simulations to the entity level to enable combat simulation in real time for interactivity with virtual manned simulators. NRaD is Technical Direction Agent; the sponsor is the Advanced Research Projects Agency.

Program accomplishments in CY 94 included the following:

Simulation Network (SIMNET) BBS. Successfully completed the 2-week functional validation test of NRaD's aggregation/deaggregation work for the BBS system with the SIMNET system in Germany. This technology was an integral part of the Southwest USA Synthetic Theater of War (STOW) and European Synthetic Theater of War (STOW-E) in late 1994.

BBS Support. Provided support to the 7th Army Training Command's (Germany) Operational

Training Exercise using the NRaD-developed BBS Advanced Interface Unit (AIU) to the Distributed Interactive Simulation (DIS) architecture.

RANGE NTDS UPGRADE SYSTEM (RNUS)

The objective of the Range NTDS Upgrade System (RNUS) program is to upgrade existing Naval Tactical Data Systems at AFWTF and PMRF to existing fleet standards; provides ACDS Block 0 programs and commercial emulator hardware. NRaD is Technical Direction Agent.

Program accomplishments in CY 94 included the following:

RNUS System Acceptance Test. Supported System Acceptance Test (SAT) for the RNUS project. RNUS uses a range version of ACDS Block 0 software.

SYNTHETIC THEATER OF WAR (STOW)

The objective of the Synthetic Theater of War (STOW) program is to demonstrate advanced distributed simulation technologies using a force structure composed of live entities, virtual simulators, and constructive simulations. NRaD is Systems Engineering and Integration Agent; the sponsor is the Advanced Research Projects Agency.

Program accomplishments in CY 94 included the following:

STOW Engineering Demonstration. Successfully conducted a STOW Engineering Demonstration. Metrics were collected on the integration of live, virtual, and constructive entities into a single STOW as the baseline for an upcoming major STOW demonstration. This demonstration integrated the RESA system, BBS system, and the NTCS-A at NRaD; the Tactical Air Range Instrumentation Facility (TARIF) at China Lake; Manned Air Simulators (AIRNET) at Ft. Rucker, and Modular Semi-Automated Forces (MODSAF) and the BBS system at the Institute for Defense Analysis.

STOW-E. Synthetic Theater of War-Europe (STOW-E), conducted concurrently with Atlantic Resolve '94, established for the first time a training battle space that allows individuals and units to raise proficiency levels. This expands the opportunity to conduct multilevel training in a joint environment by linking live operations with computer simulations.

Atlantic Resolve '94, conducted November 4–7, was the major European exercise for 1994. Atlantic Resolve '94 brought together more than 14,000 participants from France, Germany, the United Kingdom, Belgium, the Netherlands, and the United States to combine forces and enhance mutual training.

STOW-E dramatically illustrated the advantages of computer simulations to augment actual military training operations.

Information from STOW-E sites and units was transmitted over the Defense Simulation Internet (DSI).

Despite a network covering thousands of miles, STOW-E allowed Navy, Army, and Air Force participants to appear together on an electronic battlefield. STOW-E achieved this by electronically linking three different types of simulation to create a seamless, virtual battlefield. These were the Brigade/Battalion Battle Simulation (BBS), a constructive computer wargame simulation; Simulation Network (SIMNET), a virtual simulation; and live simulations that included a Navy ship; Marine Corps, Navy, and Air Force aircraft; and Army ground forces. This linking created an environment in which a field commander could not tell the difference between real and computer-generated soldiers and tactical units.

As the STOW-E integration agent, NRaD's STOW-E responsibilities encompassed three areas. Beginning mid 1994, NRaD developed the 16 Army, Navy, and Air Force sites that ultimately participated in STOW-E sites located across the United States, Germany, and the United Kingdom. To ensure participation in STOW-E, site development managed by NRaD encompassed five areas: personnel, data, procedures, hardware, and software.

By using scaleability techniques developed at NRaD, the amount of information over the DSI was maximized. As an example, software routines developed in-house transparently determined whether generated data were of value to the involved sites.

If data were required by another site, it was passed on the Wide Area Network (WAN); if not, the WAN never received this unnecessary load. A computer on each local-area network (LAN), referred to as an Application Gateway (AG), housed this decision-making function.

NRaD was also responsible for the BBS/SIMNET interface, implemented in STOW-E as the key component of the constructive to virtual aggregation/deaggregation technology. For example, SIMNET M1 tank simulators, SIMNET AH64 helicopter simulators, and the Falcon Star (F16) simulator all viewed and interacted with BBS deaggregated individual vehicles on the battlefield. This interaction was the result of a system built at NRaD, called the Advanced Interface Unit (AIU). The AIU system used standard Distributed Interactive Simulation (DIS) protocols over the DSI to allow interaction with any DIS system.

Finally, NRaD was responsible for staffing the STOW-E Engineering and Analysis Facility (SEAF) during the 2-week preparatory period, as well as during Atlantic Resolve '94. The technical control function kept all sites operational, ensuring a joint, real-time, dynamic training environment demonstration.

MOBILE ASHORE SUPPORT TERMINAL (MAST)

The objective of the Mobile Ashore Support Terminal (MAST) is to provide a rapidly deployable C^2 system for the Commander JTF or the on-scene subordinate commander.

In CY 94, program accomplishments included the following:

MAST/Fleet Mobile Operational Command Center (FMOCC). Deployed the MAST component of the FMOCC to COMUSNAVCENT Bahrain.

FLEET EXERCISE SUPPORT

In CY 94, NRaD supported Commander Second Fleet and Commander U.S. Atlantic Fleet with the following NRaD initiatives: (1) Shipboard Tracking and Telemetry System (STTS); (2) SHF- and HF-based "CHAT" communications; (3) opposition force C^3 support; (4) in-flight aircraft warning and control system (AWACS) data reduction support.

JOINT MARITIME COMMAND INFORMATION SYSTEM (JMCIS)

The Joint Maritime Command Information System (JMCIS) will provide the primary C^4I system for the U.S. Navy and Joint Task Force Commander. JMCIS is an integrated hardware and software product consisting of the core Unified Build segment and those segments developed by numerous agencies to meet specific operational requirements. NRaD provides systems engineering and integration, and is the Software Support Activity.

Program accomplishments for CY 94 included the following:

Installed the JMCIS 2.1.0.1 (with the Theater Ballistic Missile Defense JMCIS 2.1.1 functionality) on USS *Dwight D. Eisenhower* (CVN 69) (this latest JMCIS configuration is based on TAC-3 hardware and includes in excess of 30 separate software functional components); installed JMCIS 2.1.2 on USS *LaSalle* (AGF 3), the COMSIXTHFLT replacement flagship; and provided a wide range of operational and technical support.

CONTINGENCY THEATER AUTOMATED PLANNING SYSTEM (CTAPS)

In CY 94, NRaD installed CTAPS Version 5.06 software on the Joint Maritime Command Information System (JMCIS) on USS *Dwight D. Eisenhower* (CVN 69) and USS *Mount Whitney* (LCC 20), giving both ships a complete Joint Forces Air Component Commander (JFACC) afloat capability; installed CTAPS 5.0 on USS *Blue Ridge* (LCC 19). This was the first 5.0 afloat installation, using Air Force software on Navy hardware, and gives C7F a JFACC afloat capability.

TOMAHAWK STRIKE COORDINATION MODULE (TSCM)

NRaD provides systems and engineering support services to the Project Manager, PMZ 281–13, for TSCM development testing, installation, and support hardware acquisition.

In CY 94, NRaD installed the main components of the TSCM onboard the COMSECONDFLT flagship USS *Mount Whitney* (LCC 20) and installed TSCM software v1.06 beta with Tactical Aircraft Mission Planning System (TAMPS) tape interface on USS *Kitty Hawk* (CV 63). System, Central Data Base Server (CDBS) pull, and local-area network (LAN) tests were performed and TAMPS missions were transferred to TSCM.

MERCHANT WATCH (MerWatch)

The objective of Merchant Watch (MerWatch) program is to maintain merchant voyage data and provide access to related databases as well as analysis aids. NRaD is program manager.

In CY 94, NRaD completed the Preliminary Design Review for MerWatch Release D at the Office of Naval Intelligence (ONI). MerWatch provides integrated analysis tools and access to multiple databases in support of ONI merchant ship reporting missions.

BALLISTIC MISSILE DEFENSE (BMD)

NRaD completed the Navy portion of the Ballistic Missile Defense Organization (BMDO) Information Architecture and forwarded the model to Naval Doctrine Command for validation.

JOINT INTELLIGENCE CENTER PACIFIC (JICPAC) SUPPORT

NRaD provides support to the JICPAC Operational Intelligence Center (OIC), ensures interoperability between JICPAC and theater intelligence systems, and serves as liaison between NRaD research efforts and technologies of interest to JICPAC.

In CY 94, NRaD provided technical support to JICPAC during the testing of a dial-up connection over an INMARSAT-STU III-router data link between a remotely located Joint Deployable Intelligence Support System (JDISS) and JICPAC's GENSER LAN. This capability can be set up quickly and provides intelligence support to a Joint Task Force Commander during the initial hours of a contingency deployment before SHF SATCOM can be established. Future testing includes the use of communication servers that provide bandwidth-on-demand over STU-III hookups.

C^{4}I TECHNICAL ASSISTANCE

NRaD provided a C^{4}I Assist for COMNAVAIRPAC supporting USS *Constellation* (CV 64) battle group (BG) carrier qualification (CQ) and training. Dual Link-16 and Link-11 data-forwarding operations between USS *Abraham Lincoln* (CVN 72) and *Constellation* went well, with a good and consistently solid picture.

C^{4}I BATTLE GROUP TEAM

The Navy's Deputy Director for Space and Electronic Warfare Rear Adm. Wesley Jordan made a personal visit to NRaD to thank the Command, Control, Communications, Computers and Intelligence (C^{4}I) Battle Group Team. He cited their excellent job grooming the C^{4}I systems within the carrier battle group USS *Vinson* (CVN 70) prior to recent deployment.

Rear Adm. Jordan stated that concerns about lack of progress in correcting defects in the Link-16 program were well addressed by NRaD efforts. The effectiveness of Link-16 was proven aboard the *Carl Vinson* Battle Group during C^{4}I at-sea assessment tests. Rear Adm. Jordan said he was pleased with the degree all defects were resolved as noted by the Operational Technical Evaluation Force (OPTEVFOR).

The C^{4}I Battle Group team assist to the *Carl Vinson* battle group was the first Navy effort to provide technical assistance for validating the operational readiness and effectiveness of all the C^{4}I system processes prior to deployment.

The battle group includes the USS *Carl Vinson* (CVN 70), USS *Arkansas* (CGN 41), USS *Antietam* (CG 54), F-14s and E-2Cs. All are equipped with the improved Link 16 system.

C^4I TECHNICAL ASSIST FOR USS *CARL VINSON* BATTLE GROUP

NRaD organized an aggressive predeployment work-up effort to groom USS *Carl Vinson* Battle Group C^4I capability for overseas deployment. Ship and squadron personnel were trained to use new C^4I systems as an integrated suite. The effort brought together technical expertise from several field activities and established a cohesive team to assess and resolve battle group C^4I technical and operational problems.

Commander, Naval Air Forces Pacific (COMNAVAIRPAC) requested the assist to resolve problems associated with integration and use of the sophisticated systems installed in an earlier overhaul. A C^4I assist kickoff meeting was held in late October 1993 with staff members from Commander Cruiser-Destroyer Group Three, the USS *Carl Vinson* (CVN 70), USS *Arkansas* (CGN 41), USS *Antietam* (CG 54), and aircraft squadrons VAW-113, VF-11, and VF-31. They met with field activity representatives, primarily from NRaD, to describe C^4I systems performance anomalies experienced within the battle group.

This technical interchange resulted in defining a plan of action and milestones. Objectives included establishing at-sea teams, documenting various anomalies for inclusion in a tracking database, assigning action items to appropriate activities, and developing test plans, procedures, and training guidelines for use underway.

Underway periods in December, January, and February led to identification, analysis, and resolution of numerous C^4I trouble reports. This involved not only the ships, but E-2C and F-14D aircraft as well.

Success revolved around bringing together representatives from all areas of C^4I systems expertise, coordinating them into evaluation teams, and focusing their diagnostic efforts across all battle group components.

The C^4I teams used data extraction from each system, reduced the data in real-time aboard ships, and pieced together the results to isolate problems. The at-sea periods provided the crew on-the-job training and opportunities to ask questions.

Other commands contributing to this success were NCCOSC In-Service Engineering East Coast Division, St. Inigoes; Naval Surface Warfare Center Dahlgren Division and Port Hueneme Division (the division's Integrated Combat Systems Test Facility, and Fleet Combat Direction Systems Support Activity, Dam Neck, VA); Aegis Combat Systems Center, Wallops Island; and Naval Tactical Support Activity.

NRaD programs providing support included ACDS Block 0, NTCS-A, which has evolved into the JMCIS, E-2C Air Tactical Data System, C^2P, and Joint Tactical Information Distribution System.

NRaD produced the ACDS Block 0 program during 1992/93, performing in-depth functional and interoperability testing prior to delivery to *Carl Vinson*. Further testing was then conducted in the operational "real-world." Aboard *Carl Vinson*, the crew was trained in the new program's capabilities and operations. ACDS Block 0 personnel supported the C^4I assists throughout the entire period providing an at-sea technical presence, quickly responding with in-lab trouble shooting and program patch development as the need dictated.

The C^4I technical assist was an opportune time to verify effectiveness of the NTCS-A 2.0 software version. Several NTCS-A anomalies were observed at sea and resolved. The NTCS-A at-sea team was supported by numerous scientists, engineers, programmers, and testers at the ashore JMCIS Test and Integration facilities at NRaD.

NRaD engineers and Naval Flight Officers participated in troubleshooting and problem isolation of the E-2C Airborne Tactical Data System program embarking on *Carl Vinson* to observe, diagnose, recreate, and record anomalies of the mission computer's operation. A significant amount of data was collected to allow in-depth analysis and correction of problems and performance inconsistencies discovered during the C^4I assist.

The Link-16 system, comprising the JTIDS and the C^2P, is installed aboard USS *Carl Vinson*,

USS *Arkansas*, and USS *Antietam*. JTIDS terminals are installed in F-14D aircraft in VF-31 and VF-11; and E-2C aircraft in VAW-113. System interoperability became the key phrase for the NRaD personnel representing JTIDS and C^2P. NRaD personnel spent countless hours in laboratories and aboard battle group ships endeavoring to isolate Link-16 problems from other C^4I systems discrepancies. The end result was a tactical data link that combined present day capabilities with requirements of the future.

HAITI OPERATIONS SUPPORT

In CY 94, NRaD provided extensive support to military operations in Haiti. This support included the following:

Provided technical support and C^3I system grooming for USS *Dwight D. Eisenhower* (CVN 64) and USS *America* (CV 66); recreated the Joint Warrior Interoperability Demonstration (JWID) Common Tactical Picture (CTP) capability for CTF 180 (CG 18th Airborne Corps embarked on USS *Mount Whitney* (LCC 20); provided connectivity to the National Military Command Center (NMCC); reestablished a "mini" Network Operations Center (NOC) at USACOM to support the CJTF; provided round-the-clock support to the Global Command and Control System (GCCS)/Common Tactical Picture (which is essentially the JMCIS 2.1 software) effort at USACOM.

ULCHI FOCUS LENS (UFL) 94

Korean/English Translator Presented at Ulchi Focus Lens '94. "NRaD puts steel on target!!!," was the enthusiastic reaction of Lt. Gen. Charles Krulak, Commander Marine Forces Pacific (COMARFORPAC), after spending a few minutes operating a forward observer Korean/English Language Translator (KELT) prototype developed by NRaD, during Ulchi Focus Lens (UFL) '94.

Lt. Gen. Krulak was one of many U.S. and Republic of Korea (R.O.K.) personnel provided with demonstrations of KELT during UFL by NRaD employees.

UFL is a combined U.S./R.O.K. command post exercise that occurs annually in Korea. Among those given demonstrations of KELT were Colonel Kim, Head of R.O.K. Marine Corps Command, Control, Communications, Computers and Intelligence (C^4I); Colonel D'Lugos, Marine Corps Systems Command, Quantico; and Colonel Chadwick, Commanding Officer of Marine Corps Tactical Software Support Activity, Camp Pendleton.

The idea behind KELT is to provide forward observers with a hand-held, ruggedized, computer/communication device, incorporating both a Global Positioning System (GPS) and a radio interface, which will accept either Korean or English reports of tanks, enemy positions, troop movement, artillery, and aircraft sightings. The device then uses its GPS to provide fixes, converts Korean message data to English in a standard message test format, and radios these reports back to a command post. At the command post, they appear automatically on the command post computer tactical picture (map) along with parameter information.

The challenge to translating languages is to understand not only the proper vocabulary in each language, but to be able to employ the proper grammatical structure and observe the common usage conventions, which may be very different from English. Even though perfect language translation via machine is not yet possible, careful application of current technology can provide tools that are operationally effective.

Lt. Gen. Krulak envisions the warrior of the future to be equipped with a pull-down display in a front pouch of his flak jacket that would provide situational awareness, two-way communications, spoken and written language translation capability, and an extra layer of physical protection. Each Marine would then have the capability at his fingertips of communicating with every other Marine to exchange information, request resupply or medical evacuation, call for fire support, or report on position, progress, and enemy movement. KELT is a first prototype of such a system.

Colonel Paul Roques, Marine Forces Pacific Head of C^4I, requested KELT be demonstrated at UFL to show his R.O.K. counterparts that the U.S. is working to improve communications between U.S. and R.O.K. forces. It was also a prime opportunity for the KELT project team to receive valuable feedback from both services.

3-D VOLUMETRIC DISPLAY

Popular Mechanics Magazine Cites 3-D Display. *Popular Mechanics* Magazine cited the NRaD-developed Laser-Based 3–D Volumetric Display for its 1995 Design and Engineering Award. The award was presented in New York City 13 October, aboard the decommissioned aircraft carrier USS *Intrepid* (CVS 11), which now houses a sea-air-space museum.

The award is the latest in a lengthening list of recognitions for the display technology, which has been featured recently in *Popular Science*, *Business Week*, the front page of the *San Diego Union-Tribune*, and several other publications.

Originally designed for military applications the 3–D display technology shows exciting promise for such dual-use applications as air traffic control, medical imaging, and commercial television.

The innovative display employs lasers focused on the surface of a spinning double helix (resembling the spiral exit ramp of a multistory parking garage) to generate points of light in three-dimensional space, thus forming images of the data presented. The double helix provides the third dimension of height to displays that have been traditionally two dimensional.

Current air traffic control systems, for example, display aircraft in the two horizontal dimensions, with altitude shown separately. Controllers must integrate the two- dimensional horizontal display and the altitude information to ensure proper three-dimensional spacing between aircraft, particularly around busy airports.

By contrast, NRaD's 3–D display shows aircraft as discrete points of light in three-dimensional space with reference parameters such as altitude and distance from the airfield generated directly onto the display. The result is an unambiguous, easily recognized, and realistic picture of aircraft in the vicinity of the airfield.

NRaD personnel have demonstrated this capability in realtime using actual aircraft transponder data gathered by the IFF radar at NRaD.

The value of an operational system like this has prompted the Federal Aviation Administration to consider an NRaD 3–D display system for evaluation at the Washington, D.C. and Atlantic City, NJ, airports.

Working with Ocean Survey Program personnel from the Navigation and Air C^3 Department, Code 30, the 3–D display system engineers and programmers have demonstrated display of undersea topographical data to improve submarine navigation.

And working with Mayo Clinic and local physicians, the display development team has demonstrated the medical imaging possibilities of the system, including such applications as 3–D displays of a diseased heart prior to surgery and a baby's position in the birth canal to assist the obstetrician in ensuring a safe and healthy delivery.

The system also shows potential as a home entertainment center of the future. A 3–D TV would allow the whole family to watch from all sides, without the special glasses that limited traditional 3–D motion picture viewing.

The original 3–D display system is centered around a 13-inch diameter helix. The second-generation system currently in use features a 36-inch diameter helix, spinning at 600 revolutions per minute, with an acousto-optical random scanner refresh rate of 20 images per second.

The 3–D TV of the future is based on a nonmoving 3–D chamber with infrared lasers addressing special up-conversion phosphors.

MARINE SCIENCES AND TECHNOLOGY DEPARTMENT

MARINE MAMMALS

NRaD develops marine mammal systems that can perform tasks related to object detection, location, marking, and recovery; improve diagnostic and treatment techniques for marine mammals.

Program accomplishments during CY 94 included the following:

Marine Mammals Training. Completed training for all Mk 4 and Mk 7 animals in fleet systems and spares for shipboard forward deployment; passed initial certification tests in preparation for participation in RIMPAC.

RIMPAC. Three Marine Mammal Systems (MMS) completed their participation in RIMPAC exercises. The Mk 4 and 7 MMS performed well in rough seas and windy conditions. RIMPAC military operation results for Mk 4 MMS and Mk 7 MMS showed that both systems performed at 100%; compatibility with other systems was also demonstrated.

Marine Mammal Program Review. Successfully passed DoD review of marine mammal program and facilities. A Congressional mandate required DoD to review every program, project, or activity using live animals in research to ensure and certify humane use. All aspects of the program were reviewed including facilities, medical capabilities, marine mammal training and work, research, and documentation.

Sensory System Evaluation. Conducted a sensory system medical evaluation on a stranded pygmy sperm whale to determine if the whale was suitable for return to the wild. This was the first time sensory capabilities of this species of whale were evaluated. This was the first time auditory information was collected on this species and only the second time sonar pulses were recorded.

Two Dolphins Transferred From NRaD. The Navy transferred two Atlantic bottlenose dolphins on 30 August to Gulf World, a marine park in Panama City Beach, FL. Immediately preceding the dolphin transfer, NRaD held a media availability attended by more than 20 reporters and photographers representing 11 news organizations, including ABC National News and the Fox Network. The press and media were invited to view the lifting of Olive and Brinnon from their enclosures into the transporters that would take them by military cargo plane to Florida. Dan Peterson of the Marine Mammal Research and Development Branch, Code 511; U.S. Army Veterinarian Capt. Annette Freeman; Navy contractor training and care personnel; and representatives of Gulf World accompanied the animals to their destination.

Olive was collected in 1984 in Mississippi Sound near Gulfport, MS, and is estimated to be about 12 years old. Brinnon was collected in the same area in 1988, and is estimated to be about 10 years old.

Both animals were trained to work untethered in the open ocean on tasks related to object detection, location, and marking. Brinnon also had some training in swimmer detection for work in one of the Navy's operational systems.

Olive and Brinnon represent the first of 16 dolphins that the Navy has requested authorization for transfer to National Marine Fisheries Service approved facilities. Transfer has been requested but not yet authorized to Gulfarium, Fort Walton Beach, FL (four dolphins); Marine Life Aquarium, Rapid City, SD (one dolphin); Miami Seaquarium, Miami, FL (four dolphins); and Sugarloaf Dolphin Sanctuary, Sugarloaf Key, FL (five dolphins).

Les Bivens, head of the Biosciences Division and manager of the Navy's marine mammal program,

made an opening statement at the media availability, then responded to a number of questions from reporters.

He stated that the Navy Marine Mammal Program is not ending. There is still an active role in Navy research and in the support of Navy operational systems. He explained that 38 dolphins are currently employed in operational systems, trained, and worked in the open ocean. Most are trained for undersea object detection, location, and marking purposes. Some are used for recovery tasks. Twenty will be used for ongoing research studies of underwater acoustics, health, physiology, environmental pollutants in marine mammals, and to learn to manage and maintain their populations in the wild.

Twelve dolphins are retired from Navy systems. They will be cared for the duration of their lives. Of these, two dolphins from the Vietnam era will be kept with animals they have been with for 20 to 30 years. Dolphins were employed briefly in Vietnam for swimmer defense. Six dolphins were also employed in Bahrain during the escorting of oil tankers for swimmer defense.

In the late 1980s, the Navy collected about 40 dolphins for use in marine mammal systems. Working units were established in Key West, FL; Pearl Harbor, HI; and Charleston, SC. As a result of the downsizing, most of the animals have been brought to San Diego. The Navy has deemed 25 to 30 dolphins in excess to program requirements and has offered them to marine parks that can be approved by the federal regulatory agencies.

The Navy has no plans at this time to take animals from the wild again. Congress gave authorization to transfer excess animals to qualified, protective environments. The Navy offered animals to 100 marine parks and Gulf World is the first park to be approved.

Transferring animals from the Navy will save taxpayers $10,000–$15,000 a year per animal for food and medicine. Providing excess animals to marine parks will prevent animals from being taken from the wild.

The dolphins were collected for national defense purposes and research, and are adapted to working with and being under the care of humans. They will adapt well to their new environment. The idea of releasing them to the wild was examined but determined not an option for the Navy at this time. It would not be in the dolphins' best interest because of their feeding and socialization habits; and the fact that the animals are trained to come to people and boats.

The animals arrived at Tyndall Air Force Base in Panama City and were taken by truck to Gulf World where they began eating almost immediately and were reported as being in excellent condition following the flight.

SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM (SCAPS)

The Site Characterization and Analysis Penetrometer System (SCAPS) is a Tri-Service technology effort led by the U.S. Army. Initial integration of a fiber-optic-based laser-induced fluorescence sensor for petroleum, oil, lubricant (POL) contaminants into a standard geotechnic cone penetrometer was a collaborative effort with U.S. Army Waterways Experiment Station (WES) and NRaD. Technical success generated high sponsor interest for rapid maturation and introduction of the technology to POL-contaminated Hazardous Waste Sites. Acquisition and dual-use of SCAPS for continued technological development and regulatory acceptance and preliminary site characterization as a strategy was adopted.

Program accomplishments in CY 94 included the following:

SCAPS Assessment Work. Completed SCAPS assessment work for the State of California. The operation was a success, with approximately 30 pushes (profiles) conducted to document the extent of contamination.

SCAPS EDM-1. Deployed SCAPS EDM-1 system to NAS, Alameda with significant results; the probe in use was the first NRaD product. Engineering Development Model-1 was scheduled to operate at the Marine Corps Air Station (MCAS),

Yuma; potential site assessment cost savings of $1M were identified. Completed field operations, Yuma. Twenty-three pushes were made, with a 72-foot maximum depth. Pre-deployment efforts began for Marine Corps Base (MCB), Camp Pendleton.

SCAPS Deployed in Support of State and Unocal. "An excellent example of dual use technology and cooperation between government agencies and industry," was the comment by NRaD Commanding Officer Capt. Kirk Evans about the latest application of SCAPS. The California Department of Fish and Game and the California State Water Quality Board requested use of the SCAPS system to assist the state and Unocal Oil Company in a ground cleanup effort at the Guadalupe Oil Field in central California near San Luis Obispo.

NRaD originally developed the POL sensor and installed it on the NRaD survey craft, the Ecos. He collaborated with the Army to create a system to detect POL contaminants. NRaD's technology was integrated with a cone penetrometer and used for soil surveys in the construction industry. This cooperative effort created SCAPS. It put a real-time fiber-optic-based chemical sensor system in a probe that is pushed deep into the ground using the reaction mass of a 20-ton all-wheel drive cone penetrometer truck.

The Guadalupe oil field is bordered by agriculture, State and private preserve areas, and the Pacific Ocean. It was determined that pollution occurred through oil seepage and chemical compound leaks into area soil, beach sand, and the ocean. Unocal evaluated the extent of the damage and amount of clean up required during the site investigation phase.

The State requested SCAPS assistance to validate the amount and extent of pollution reported by Unocal to determine if the proposed clean up efforts were adequate.

The system was deployed at the Guadalupe Oil Field and the SCAPS team spent 3 weeks in the Central California coastal surroundings of sand dunes, surf, native vegetation, and wildlife.

During the first 2 weeks, 38 investigative locations, designated by the State, were analyzed by the SCAPS team. Unocal provided data and support to assist the SCAPS team during on-site operations.

Real-time data was immediately available, and as the first 2 weeks progressed, Unocal's data was proved accurate.

A half-dozen carefully selected sites were further probed on the third week using traditional methods accepted by the Environmental Protection Agency. Drill rigs made soil borings and the team extracted and controlled soil samples. These were sent to State- certified analytical laboratories for contaminant analysis.

The State of California must next evaluate the number of gallons of contaminants in the soil for negotiations with Unocal to determine the restoration program. Unocal has already taken the initiative by removing tons of beach sand, thermally treating it, and returning it to the beach site. They were careful to consider the nesting of native birds and the protection of native plant species.

NRaD involvement in this project was endorsed by the SCAPS sponsor, Naval Facilities Engineering Service Center, Port Hueneme. The SCAPS team developed an excellent cooperative effort with State of California representatives and Unocal representatives. Unocal expressed interest in the SCAPS system as a future way to determine if chemical pollution has occurred and how much, and how to approach remediation.

The government is currently working toward technology transfer to the commercial sector. The Navy will eventually be in the position to purchase it as a service from the contractor. The Navy's immediate requirement for the system is so high that it has purchased three systems.

MOBILE DETECTION, ASSESSMENT, AND RESPONSE SYSTEM (MDARS)

The Mobile Detection, Assessment, and Response System (MDARS) program provides technical support for the Tri-Service DoD MDARS Security Robotics program.

Program accomplishments in CY 94 included the following:

Installed a K2A robotic platform along with the latest Multiple Robot Host Architecture software, officially marking the beginning of Category II software field development.

Completed Category II system tests at Camp Elliott; more than 50 individual tests were successfully completed.

WATERSIDE SECURITY SYSTEM (WSS)

The Waterside Security System (WSS) detects, classifies, localizes, and assesses waterborne threats attempting to gain access to critical waterside assets.

Program accomplishments in CY 94 included the following:

WSS C^3 Display. Successfully completed the First Article Acceptance Test on the WSS Command, Control, and Communication Display.

WSS Sonars. Successfully installed and tested two sonars. The sonars included the CSAS-80, a sonar developed by C-Tech of Canada for the Swedish Navy, and the AN/WQX-2, a sonar developed by ARL:UT under the Navy's Shipboard Physical Security program.

WSS Bangor. Completed the non-sonar component installation at NAVSUBASE Bangor.

ENVIRONMENTAL PROGRAMS

Environmental program accomplishments in CY 94 included the following:

Community Environmental Activity. Presented a summary of NRaD's work in San Diego Bay at a Navy-sponsored San Diego Bay Sediment Monitoring and Testing Workshop attended by many local, state, and federal agencies and environmental firms.

PCB Detector System Demonstration. Demonstrated the NRaD-developed portable PCB Detector System at the Puget Sound Naval Shipyard. This system will save substantial analytical costs by rapidly measuring PCB contamination on decommissioned submarines prior to disposal, thus expediting cleanup procedures.

Organotin Monitoring on USS Leftwich (DD 984). Monitored organotin levels of USS *Leftwich* during removal of the ship's organotin antifouling paint. USS *Leftwich* is the last U.S. Navy ship still coated with organotin antifouling paint; this completed a 20-year history of the Navy's research and testing of these coating systems.

MICROELECTRONICS

Program accomplishments in microelectronics in CY 94 included the following:

Indum Phosphide (InP) Transistor. Developed a high-performance InP opto-electronic switching transistor for the Microwave Antenna Program. The transistor yields an ON resistance of less than 7 ohms and an OFF resistance in the range above 10K ohms. Such devices are expected to play a major role in the Wireless Reconfigurable Antenna, with low loss and high isolation.

Sensor Arrays. Fabricated sensor arrays with a functional yield exceeding 70%. The NRaD Microelectronics Facility used a new process designed to enhance the reliability of Trident stellar sensor arrays. This new process uses implants of an ionic species known to improve the reliability and longevity of integrated circuits that must be stored and operated in adverse environments.

Multilayer Wafers. Verified the structural configuration of organometallic vapor phase expitaxial (OMVPE)-grown InP/indium gallium arsenide (InGaAs) multilayer wafers produced by NRaD. Carrier concentration profiling measurements were made to verify the configuration. The NRaD power transistor group is currently using these wafers in the development of microwave/mm-wave heterojunction bipolar transistor (HBT) devices that are expected to play a major role in Navy electronic warfare, surveillance, missile guidance, and satellite communications systems.

Polarization Independent Narrow Channel (PINC) Wavelength Division Multiplexing (WDM) Fiber-Optic Coupler. Investigated the feasibility of compressing the wavelength channel separation of NRaD's in-house-developed PINC WDM fiber-optic coupler to 8 nanometers (nm); the channel wavelengths are in the

1550-nm region where fiber loss is a minimum and erbium-doped fiber amplifiers (EDFAs) operate. Previously, NRaD demonstrated channel separations as small as 16 nm. Loss is extremely low, on the order of a few tenths of dBs, and cross-talk is less than 3%.

Microelectronics Project. Successfully fabricated 100- x 100-synapse, 100-neuron analog neural network (ANN) integrated circuit in fully depleted 100-nm thin-film silicon on sapphire (TFSOS). Preliminary characterization indicates that programming and learning have been demonstrated. The ANNs are pervasive and applicable to as varied (littoral/space/surveillance) warfare scenarios as space, ASW, avionics, missiles, and mines/mine countermeasures. Pattern recognition and image processing are the main military applications for implementation. Commercial applications (identification/classification and signature/speech recognition) are found in banking, perimeter surveillance, and law enforcement.

Ion-Sensitive Field-Effect Transistor (ISFET). Completed and delivered the first full lot of chemical sensors based on the ISFET to UNIFET, a local company specializing in silicon-based chemical and biological measurement instruments. Very high yield was obtained on devices showing excellent electrical characteristics and high chemical sensitivity. A Cooperative Research and Development Agreement (CRADA) with UNIFET will cover the joint development of new sensors and sensors integrated with on-chip electronics.

CONTROL PANEL MK 309 MOD 2

NRaD engineers successfully completed the last major milestone of the Control Panel Mk 309 Modification (Mk 309 Mod 2) project. An Engineering Development Model (EDM) was installed aboard the USS *Ford* (FFG 54). Torpedo firing exercises were conducted on 6–7 October on the Canadian Forces Maritime Tracking Range, Nanoose, British Columbia. Both Mk 46 and Mk 50 torpedoes were fired successfully. This test represented the first over-the-side firing of a Mk 50 torpedo from a fire control system specifically designed to fire these new torpedoes.

The Control Panel Mk 309 Mod 2 is a torpedo firing panel used during over-the-side torpedo delivery aboard FFG 7 class frigates. The Mk 309 interfaces directly to the Surface Vessel Torpedo Tubes Mk 32 and can fire both Mk 46 Mod 5 and Mk 50 torpedoes. Its functions include single target motion analysis with automated torpedo attack recommendations, display of weapon inventory, torpedo selection, torpedo presetting, and torpedo firing.

NRaD selected the Versa Module Eurocard (VME) bus "open system" architecture. Three custom VME boards were designed to handle torpedo tube input/output (I/O), synchro analog signal conversion, and miscellaneous relay outputs. The main central processing unit board is a DY-4 68020-based intelligent serial I/O controller. The graphical user interface consists of two Science Applications International Technology (SAIT) electroluminescent flat panel displays with infrared touch screens. These displays are intelligent terminals that provide VGA quality monochrome graphics via an RS-422 port. The Mk 309 uses an NRaD-designed VME J2 backplane that routes all external I/O signals through the user-defined pins on the VME bus P2 connector. The Mk 309 uses a modular design approach that permits hardware upgrades for future system requirements. Modifications for future weapon upgrades will be accomplished through firmware revisions. Extensive self-test capabilties isolate faults down to the lowest replaceable module. Commercial off-the-shelf (COTS)/nondevelopmental item (NDI) devices were used wherever possible.

The Mk 309 was subjected to a complete set of military qualification tests including electromagnetic compatibility (EMC) tests, environmental tests, power compatibility tests, independent validation and verification (IV&V) checks, and shipboard integration tests.

Foreign military sales (FMS) are a potential market for the Mk 309 Mod 2. Several foreign countries are in the process of building new and smaller ships. FMS applications include firing Mk 44 torpe-

does, controlling vertical launch antisubmarine rockets, and interfacing to digital sensors.

All phases of this program were done by a naval activity with minimal contract support. The PIDS and SRS was developed by NRaD with Hughes Aircraft Corporation support. EMC testing was performed at the Naval Air Warfare Center, Point Mugu.

Enviornmental testing was done by NRaD. Naval Undersea Warfare Center, Division Keyport provided logistic support and will produce all future Mod 2 units. The Level III documentation package was created by NRaD. All EDM fabrication was performed by the Public Works Center (PWC).

RESEARCH AND TECHNOLOGY

Research and technology program accomplishments in CY 94 included the following:

Pilot-Line Experimental Technology (PET). Completed characterization of a 128 x 128 HgCdTe focal plane array. Optical and electrical performance has been examined in both clear and gamma environments. The device was fabricated by Loral Infrared & Imaging Systems under the PET Program.

Ceramics Pressure Housings. Completed a successful pressure test of a 25-inch diameter alumina ceramic herispherical end closure. Testing included a single pressurization to 10,000 psi with a 1-hour hold, followed by 500 cycles to 9000 psi. The assembly survived the test with no structural degradation.

Missile Motor Railcar Transporter (MMRT) Environmental Controller. Completed successful initial testing of MMRT Global Positioning System (GPS)/Cellular tracking prototype at Magna, UT. Preliminary test results indicate that automatic dial-up and transmission of position data to the San Diego prototype base station were successfully achieved.

Marine Aerosol Properties Thermal Imager Performance (MAPTIP). Completed a month-long data collection effort in the field program phase. MAPTIP involved eight NATO countries and was conducted off the coast of the Netherlands.

InP-Based Heterojunction Bipolar Transistors (HBTs). Completed a process modification dramatically improving the breakdown characteristics and power handling capability of InP-based HBTs fabricated on their ONR program. The InP/InGaAs multilayer material structure used to fabricate these devices was grown at IBM using Molecular Beam Epitaxy (MBE). InP-based HBTs are expected to play a major role in future Navy microwave/millimeter-wave systems.

Optical Electronics. Completed the upgrade and realignment of the fiber-coupled scanning Michelson interferometer used for optical waveguide characterization measurements. Significant noise sources were eliminated/minimized by the use of improved mounting components and electronic filtering. A 20X improvement in signal-to-noise ratio has been achieved.

Fabrication of Nanowires. NRaD personnel, Michael Winton (ONR Summer Fellow), Andrew Katz and Prof. Robert Dynes (UCSD) have collaborated on the fabrication of nanowires under an NRaD IR program.

The team demonstrated the fabrication of silicon wires 30 to 50 nm wide (less than 100 atoms wide) and nominally 10 nm thick on a sapphire substrate. The goal of the program is to investigate light emission from such nanostructures for optoelectronic and flat panel display applications.

Charged-Coupled Devices (CCDs) Laser. Received initial test results from NASA's Jet Propulsion Lab on CCDs laser processed by NRaD that show a quantum efficiency (QE) of 65% at 600 nm. This exceeds that of conventional self-accumulated CCDs and those fabricated using molecular beam epitaxy techniques. Increased QE was measured over a wide range of wavelengths from 400 nm to 1000 nm. The NRaD laser process was developed for the TRIDENT program, and is being considered for use in the advanced solid-state camera for the upgraded Hubble telescope and other JPL programs.

Artificial Neural Network (ANN). Demonstrated an analog 100- x 100-synapse, 100-neuron ANN,

with parallel, on-board (i.e., on-chip) learning. This milestone alleviates difficulties and pitfalls of the past by implementing a promising ANN algorithm in hardware. This learning algorithm and the circuit designs to implement it have been developed from inception at and patented by NRaD; the architecture is that of a Multilayer Perceptron (MLP) with modified trinary form of back-propagation learning (also patented by NRaD) which estimates posterior probabilities. This architecture is useful for generic function approximation (in deterministic and stochastic environments), acquired by supervised training.

SURVEILLANCE DEPARTMENT

RELOCATABLE OVER-THE-HORIZON RADAR (ROTHR)

The Relocatable Over-the-Horizon Radar (ROTHR) is a ground-based, bistatic radar system designed to provide long-range detection, tracking, and reporting of air and surface targets operating in its area of coverage.

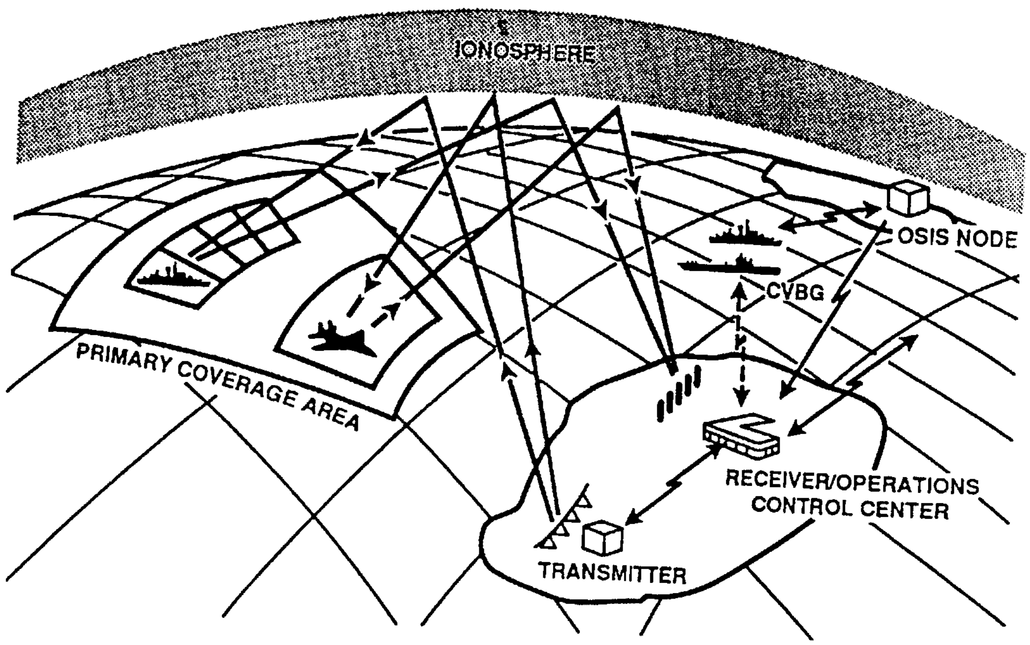
The ROTHR transmitter emits FM radio energy in the high-frequency (HF) range, between 5 and 28 MHz. The transmitted energy is refracted in the ionosphere back onto the earth's surface in the area of interest. The surface of the earth and the targets in the area of interest reflect some of this energy back through the ionosphere to a separate receive site, where it is processed to generate target track information. This information has varying degrees of accuracy due to the changes and uncertainties of the ionosphere caused by factors such as the time of day, season, sun spot number, and other solar activity.

Program accomplishments in CY 94 included the following:

JOTS-ROTHR Interface. Installed an upgrade to the JOTS-ROTHR Interface (JRI). This software enhancement to the JRI segment will allow operators to estimate ROTHR-Virginia coverage availability based upon yesterday's ionospheric conditions. This feature will be used by CJTF Four to plan force laydown in the Caribbean region.

INTEGRATED UNDERSEA SURVEILLANCE SYSTEM (IUSS)

IUSS System Software Support. NRaD is the Integrated Undersea Surveillance System (IUSS) SSSA and provides software maintenance support for IUSS field subsystems.



The ROTHR concept.

In CY 94, NRaD successfully completed testing of the IUSS Block 3 software in NRaD's Surveillance Test and Integration Center (STIC).

The operational demonstration of SPOTLIGHT at the Dam Neck Validation Center (DSVC) began on 1 December with operator training, with the demonstration continuing through the month. The SPOTLIGHT ATD successfully concluded with this demonstration, and transition of the technology is scheduled for implementation in the Surveillance Direction System.

SOUND SURVEILLANCE UNDERWATER SYSTEM (SOSUS)

In CY 94, NRaD successfully installed IUSS Block 3.0 (Pacific Ocean). This completed both oceans for this latest software build.

SHALLOW-WATER EVALUATION CELL EXPERIMENT (SWELLEX)

In CY 94, NRaD completed SWEllEx-3. The experiment gathered acoustic and environmental data to validate NRaD shallow-water surveillance techniques, including arrays, models, and signal processing. The experiment included over 100 source tows, over 300 full-water-column environmental profiles, and included such novel tests as aircraft-to-water acoustic coupling, mine laying acoustic detection, "croaker" (fish) noise chorus background characterization, and broadband matched-field processing detection.

TACTICAL RELATED APPLICATIONS (TRAP) BROADCAST SYSTEM

The Tactical Related Applications (TRAP) broadcast is a worldwide broadcast system that disseminates high-interest reports in near-real-time to tactical commanders with Tactical Receive Equipment (TRE). The TRAP equipment receives these reports from a number of sources, reformats and compresses the data, and transmits them to the TREs via UHF satellite communication satellites. Some TRAP sites also serve as relay sites to relay the data from one satellite to another, thus making the TRAP broadcast worldwide.

Program accomplishments in CY 94 included the following:

TRAP Data Dissemination System Source Input Installation. Completed installation and testing of a source input capability for Joint INTEL Center Pacific (JICPAC). This capability allows JICPAC to directly inject their data onto the TRAP broadcast. It now takes under 30 seconds for their data to be sent by TRAP vice up to and exceeding 10 minutes via the previously used method.

MULTIMISSION ADVANCED TACTICAL TERMINAL (MATT)

VAQ-209 installed a MATT in one squadron aircraft and participated in the Radiant Oak Concept Demonstration. VAQ-209 successfully launched the first operational improved warhead High-Speed Anti-Radiation Missile (HARM) against a ship at sea using over-the-horizon targeting data from national systems delivered directly to the AE-6B cockpit in near real time (NRT).

CENTERBOARD

Successfully completed CLASSIC CENTERBOARD TECHEVAL Phase II.

CERCIS

The CERCIS Program is a DoD-sponsored program that will provide the next-generation replacement of the Southern California Offshore Range Environment/SIGINT Universal Recognition Facility (SCORE/SURF) operational capabilities developed by NRaD. Program initiation was in 1991 with NRaD taking the lead for DoD to design, develop, and implement the components of CERCIS that will meet all Navy requirements and supercede the existing SCORE/SURF functionality currently on site.

Program accomplishments in CY 94 included the following:

CERCIS (NSA). Completed incremental delivery of CERCIS 2.0 fixes (a result of a successful DT&E effort last calendar year). Software changes were transmitted to NSA using PLATFORM connectivity from NRaD. In addition, preliminary software to provide core release 3.0 capability that will result in an upgraded FY 95 delivery were completed and transmitted. The 3.0 release will provide full functional replacement for the NRaD-developed SCORE/SURF systems currently in operational use.

SURVEILLANCE TOWED-ARRAY SENSOR SYSTEM (SURTASS) AND LOW FREQUENCY ACTIVE (LFA)

NRaD provides system engineering for the development efforts and conducts development, operational, acceptance, and certification tests as Technical Development Agent (TDA). SURTASS-related accomplishments in CY 94 included the following:

Surveillance Towed-Array Sensor System (SURTASS) Installation. Installed SURTASS TX Build 5 (Shore) in the STIC. Communications were established with the R12 ship hardware at NRaD and the TX Ship hardware at HAC (via SATCOM).

SURTASS T-AGOS 21 Certification Test. Conducted a successful At-Sea Certification Test aboard USNS *Effective* (T-AGOS 21). NRaD served as the Test Director and the Acoustic Principal Investigator. T-AGOS 21 was recommended to be certified for IOC.

T-AGOS 20 Certification Test. Conducted a successful At-Sea Certification Test aboard USNS *Able* (T-AGOS 20). Operations were conducted to determine the response characteristics of desensitized hydrophones in the RDA array. End-to-end operational availability was 99%. Detections and holding times of targets of opportunity were excellent. T-AGOS 20 was recommended to be certified for fleet operational use.

AIR DEFENSE INITIATIVE DUAL-USE

An NRaD signal processing system, originally designed to track Soviet submarines, was used to help safeguard whales and other mammals during shock trials of the Navy's new Arleigh Burke class Aegis guided missile destroyer, the USS *John Paul Jones* (DDG 53).

A shock trial involves detonating a 10,000-pound explosive charge near the ship being tested. Shock trials are an essential part of the test and evaluation process for each new class of ship. They provide vital data that cannot be obtained by computer simulations or small-scale component tests to ensure that the ship and its crew survive and prevail in battle after being subjected to nearby explosions such as the detonation of a mine. The shock trials on the DDG 53 were conducted in an area about 90 nautical miles southwest of San Nicholas Island.

In compliance with the Marine Mammal Protection Act, the Navy worked with the National Marine Fisheries Service (NMFS) to obtain the required permits and to select a test area where marine mammals were least likely to be found. Potential shock trial areas were visually surveyed from aircraft by NMFS marine biologists for over a year prior to the start of the trials in an attempt to select an area having a low density of marine mammals.

Before NRaD's involvement in the shock trial program, the procedure established to certify an area to be clear for a shot was based entirely on visual surveys by NMFS observers from ships and aircraft.

While visual observations were an essential element in certifying an area to be clear for a shot, especially for the smaller marine mammals such as dolphins and seals, it was believed that the addition of an acoustic monitoring capability would substantially reduce the risk of injury or death for the larger marine mammals (primarily whales) known to be present at times in the trial area. Some of these mammals dive to great depths and stay submerged for periods of up to 90 minutes.

The multichannel processing system used in the shock trial was under development for the Air Defense Initiative (ADI) program when it was terminated a year ago due to defense spending cuts. The potential application to the shock trial program prompted sponsors in the Undersea Warfare Program Office of Space and Naval Warfare Systems Command to establish a new dual-use effort aimed at tailoring the system to the marine mammal detection and localization problem.

NRaD (with ORINCON Corporation) modified the ADI processor to detect vocalizing whales and renamed it the Marine Mammal Acoustic Tracking System (MMATS). After convincing demonstrations of the system's ability to detect

and localize whales, it was approved for inclusion in the shock trials.

Despite the substantial precautions taken by the Navy to mitigate the risk of killing or injuring marine mammals during the conduct of the shock trials, environmentalists concerned about potential harm to marine mammals filed a lawsuit in federal court to prevent conduct of the tests. Resolution of that suit, which allowed the Navy to proceed with the shock trials, was substantially aided by the high-technology approach offered by MMATS.

When the shock trials finally got underway, MMATS was installed on a Navy P-3 aircraft together with an NRaD-furnished Global Positioning System (GPS) receiver. Prior to a shock trial shot, the P-3 crew deployed a precisely located sonobuoy field to monitor the test area.

Underwater sounds received by the hydrophone at each sonobuoy location were transmitted to the aircraft, where sophisticated signal processing equipment allowed mission specialists experienced in the identification of marine mammal vocalizations to detect, localize, and track the whales. Throughout the trials all visual and acoustic survey teams were in continuous communications with the NMFS biologist on the bridge of *John Paul Jones*. Any sign of marine life within the test area resulted in an immediate delay or cancellation of the shock trial.

For these trials, MMATS processed 10 channels of sonobuoy data. The parameters for the sonobuoy field were established using acoustic predictions made on the Interactive Multi-Sensor Analysis Trainer developed at the Navy Personnel Research and Development Center.

A high-tech feature of the MMATS system was a neural network processor trained to recognize whale vocalizations and signal the operator when detections were made. MMATS was configured to detect a variety of marine mammals including blue, finback, sperm, minke, gray, and humpback whales. Whale vocalizations usually consist of a set of signals that are repeated at regular intervals, with repetition rates varying from 1 second to 2 minutes, depending on the species. Species identification of a submerged whale was done by examining the distinctive frequencies and patterns of the vocalizations and confirmed by the NRaD mission specialists aboard the P-3.

The location of a mammal was determined by hyperbolic fixing based on the time of arrival difference of signals at pairs of sonobuoys.

In several instances, the shock trials were delayed for hours or days based either on the presence of marine mammals or on bad weather, which prevented adequate observation of the area. Blue whales were located in the test area by MMATS during both days that shock trial detonations were made. These acoustic detections were subsequently confirmed by the NMFS visual surveys. As a result of these detections, the test ships moved to a different part of the test range where both visual and acoustic surveys indicated there were no animals. The shock trials were then successfully completed. Surveys after each shot aboard the survey ship McGaw confirmed that no marine mammals were harmed by the shock trials.

The NRaD efforts were recognized in a letter of appreciation from the Aegis Program Manager. Other applications of this technology to future shock trials and other dual-use applications are currently being pursued.

CRYPTOLOGIC UNIFIED BUILD (CUB)

The objective of the Cryptologic Unified Build (CUB) program is to develop an open systems architecture for afloat cryptologic applications that is JMCIS Unified Build compliant.

Program accomplishments in CY 94 included the following:

CUB 1.1. Performed formal integration for the CUB 1.1 Release. This release is a major milestone in the development of an open systems architecture for afloat cryptologic applications that is JMCIS UB compliant.

CUB 1.2. Successfully completed TECHEVAL (DT) of CUB 1.2 software developed by NRaD, with support from NRaD Det Philadelphia, NISE-East, and several support contractors.

GHOST

NRaD successfully completed OPERATION GHOST, a joint AIREM and Advanced Deployable System (ADS) ASW exercise in Argentina. The arrays were retrieved and it was verified that data was successfully recorded; ARL/UT scanned the data and confirmed that it is a very clean, high-quality data set.

SPINNAKER ARRAYS

NRaD recovered Spinnaker lightweight low-power demonstration arrays (deployed for the Site Specific Experiment) in fully operational, "live" (fully functional status) after the experiment. A digital recorder designed by the Marine Physical Laboratory (MPL) was interfaced to the arrays in the NRaD laboratories, and the arrays were tested in the laboratory to identify the source of any problems seen during the experiment. The technology and techniques developed opens new possibilities in ocean array deployment and use.

PORT AREA SURVEILLANCE (PAS) ELECTRIC FIELD SENSOR DEPLOYMENT

NRaD participated in the successful at-sea deployment of two pairs of Canadian electric field sensors in the vicinity of Neah Bay, WA. The sensors serve as reference sensors in support of other sensors in the area. NRaD also participated in an at-sea test of USS *Stonewall Jackson* (SSBN 634) and collected magnetometer data using the PAS TI array.

dB MASTER

NRaD released dB MASTER, an analytical reference tool, portable to SUN Sparc workstations, that provides on-line access to a variety of intelligence reference material. dB MASTER is operational at JICPAC, SOCPAC, USSOCOM, USACOM JIC, and additional shore sites.

OCEAN TEMPERATURE SENSOR ARRAY

NRaD fabricated a lightweight, low-power ocean temperature vertical sensor array using Spinnaker technology. The array was suspended from Research Platform Flip for the Shallow-Water Environmental Cell Experiment 3 (SWEllEx-3); the array continuously measured ocean temperatures through the water column to monitor ocean climatic conditions during SWEllEx-3, an ocean surveillance validation experiment.

TRIDENT STELLAR SENSOR ARRAYS

NRaD demonstrated good functional yields in two recent lots of Trident stellar sensor arrays following major changes in processing parameters. A significant reduction in gate oxide thickness (from 100 nm to 50 nm) was introduced to reduce radiation sensitivity and to reduce the cost of the sensor array by eliminating a troublesome yield-limiting problem.

SHALLOW-WATER SENSOR SYSTEM (SWSS)

The SWSS was successfully deployed in 200 meters of water west of Point Loma in the Southern California Shallow-Water Test Bed. Deployment of SWSS marks the culmination of several advanced technology efforts, including lightweight powered fiber-optic cables, miniaturized total-field magnetometers, and extended application of the previously demonstrated analog multiplexed sensor strings (slackline arrays). Also, this marks the first use of pressure-tolerant electronics, so no large pressure housings were used.

3–D ACOUSTIC SIMULATIONS

NRaD employed Dr. Homer Bucker's 3–D Gaussian Beam model in a series of acoustic simulations of ADS array concepts, using a topographically complex Mediterranean site. Dr. Bucker's model is the only acoustic model in the world to fully incorporate 3-D topography effects in a manner computationally efficient enough for extended studies. Including 3–D effects had a clear impact on the simulation results.

MAN-TRANSPORTABLE SPECIAL OPERATIONS COMMAND RESEARCH, ANALYSIS, THREAT EVALUATION SYSTEM (SOCRATES) (MTS)

NRaD successfully demonstrated MTS at the Joint Warrior Interoperability Demonstration. The demonstration included establishing connectivity to the SCI LAN at the Atlantic Intelligence Center (AIC) in Norfolk, VA, via the Special Operating Forces-Intelligence Van (SOF-IV), which uses secure UHF communications.

LOW-LEVEL SERIAL SWITCH (LLSS)

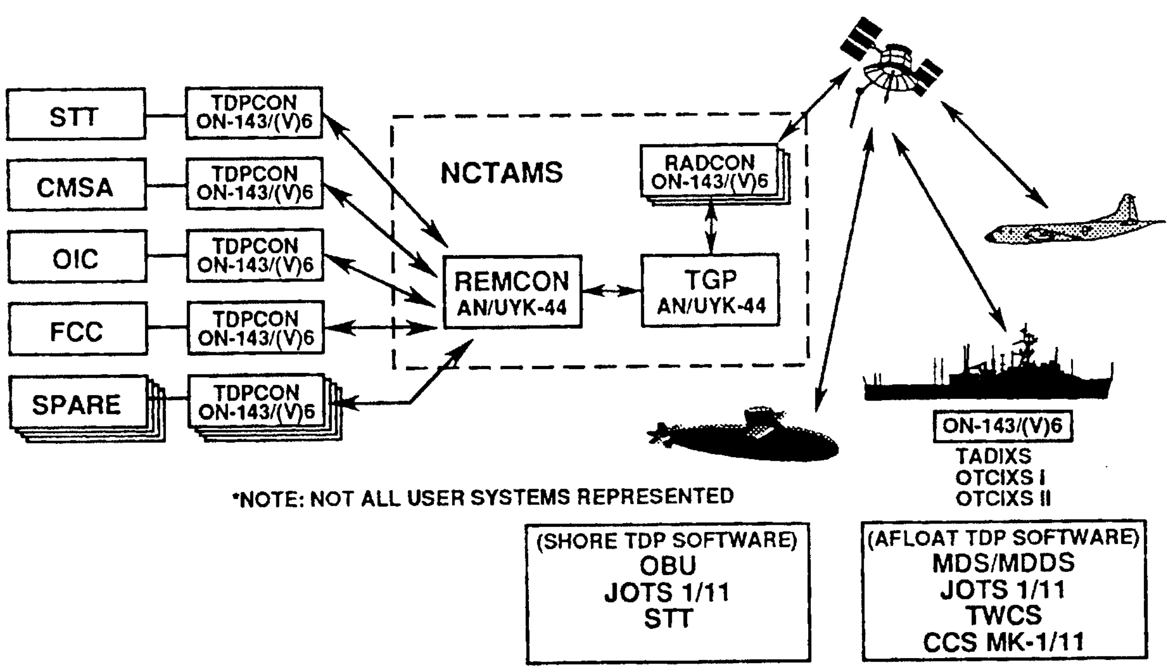
NRaD assisted with the total check out and integration of the third LLSS in support of AEGIS programs. All three switches were trunked together and controlled successfully with the new software system.

HIGH-SPEED HF

NRaD operated a 4800-bps full-duplex channel over existing shipboard high-frequency radio equipment between USS *Duluth* (LPD 6) and USS *Peleliu* (LHA 5). This channel supported VVFD terminal text and image exchanges using Harris 5254C single-tone serial modems and KG-84s at ground wave distances out to 75 miles. The feasibility of extending this full-duplex link to shore was tested and verified using standard Marine Corps HF radios.

TACTICAL DATA INFORMATION EXCHANGE SUBSYSTEM (TADIXS)

The Tactical Data Information Exchange Subsystem (TADIXS) is designed to support the exchange of over-the-horizon targeting (OTH-T) information between shore and Fleet-based computer systems (collectively referred to as tactical data processors [TDPs]) for Navy cruise missile operations. The current ON-143/(V)6 software contains the TADIXS and Officer-in-Tactical Command Information Exchange Subsystem (OTCIXS) programs, and the submarine version additionally hosts the special-interest and general-service Submarine Satellite Information Exchange Subsystem (SSIXS) subscriber program, the FLT SECURE voice, and TACBUOY programs. This program supports both the KG-35/36 and KG-84A crypto, with the next upgrade to include KG-84C. The TADIXS/



TADIXS Phase IV.

OTCIXS programs provide inter- and intra-Battle Group communications and are designated as the return path for ship-to-shore OTH-T communications.

TADIXS Phase IV will replace the currently operational Phase III shore system. Phase IV will provide worldwide integrated connectivity among the OTH-T community, using dedicated landlines and satellite links, through a series of computer-controlled switching nodes called TADIXS Gateway Facilities (TGFs).

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Phase IV consists of four computer programs hosted on two ON-143/(V)6s and two UYK-44s. The TADIXS Gateway Processor (TGP) and Remote Controller (REMCON) programs are hosted on the UYK-44 and the Tactical Data Processor Controller (TDPCON) and Radio Controller (RADCON) on the ON-143/(V)6.

Phase IV provides improved message routing and accountability and a demand-assigned multiple-access (DAMA) capability for the OTCIXS user. Additional benefits include reduced satellite channel loading through the use of dedicated landlines for data transmission and equipment redundancy.

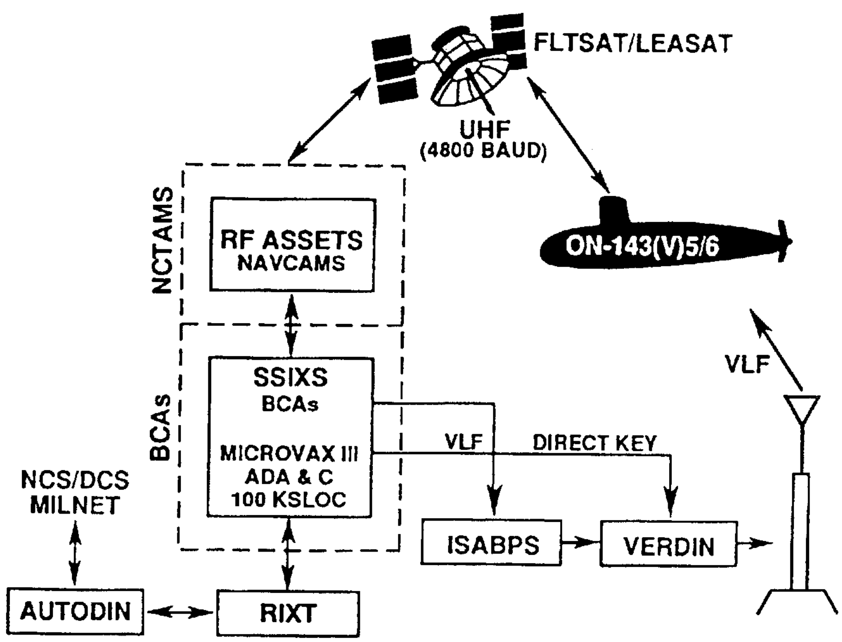
Program accomplishments in CY 94 included the following:

Tactical Data Information Exchange System (TADIXS) Transition. Continued TADIXS Phase IV transition at CINCPACFLT, with the Fleet Command Center (FCC) and Cruise Missile Support Activity (CMSA) on line and operational. All operator training was completed.

On-Site Technical Support. Continued CINCPACFLT support for TADIXS Phase IV. With the successful completion of the 25-hour system stress test, CINCPACFLT approved the final installation of the upgraded software.

SUBMARINE SATELLITE INFORMATION EXCHANGE SUBSYSTEM (SSIXS)

The Submarine Satellite Information Exchange Subsystem (SSIXS) is a DEC Ada program hosted by a MICROVAX III CPU. It is a UHF



Submarine Satellite Information Exchange System (SSIXS).

system that provides the submarine commander with the capability to exchange encrypted general-service and special-interest text message traffic between SSNs and SSBNs and the shore Broadcast Control Authorities (BCAs). Messages are transmitted from shore via satellite at scheduled intervals, called "group broadcasts." Between group broadcasts, submarines may transmit messages to the BCA or request messages held in queue, "query/response." These two modes of operation, group broadcast and query/response, permit the submarine commander to maintain either an active or passive posture.

In CY 94, NRaD successfully completed certification of the Royal Navy SSIXS Rehost Unit. This system contains the UYK-20 emulator that replicates a UYK-20 and is hosted on a VME board in a DTC-2 chassis.

HIGH-DATA-RATE LAMPS MARK III SHIP-TO-SHIP LINE-OF-SIGHT COMMUNICATION SYSTEM

Early in FY 1993, NRaD began investigating the most viable technical approach to achieve high-data-rate (HDR) line-of-sight (LOS) communications between Navy ships in a battle group. The results of previous efforts were examined as well as the state-of-the-art in microwave technologies, available electromagnetic frequency bands, and shipboard locations for possible antenna installations.

In this effort HDR was defined as the ability of two ships to simultaneously conduct two-way data transmission and reception at data rates of at least 1.544 million bits per second (Mbps). This rate is a commercial standard pioneered by Bell Telephone and is referred to as T1. Satisfying this standard means future Navy HDR systems can use existing equipment purchased in the commercially competitive marketplace rather than develop its own.

The USS *Conolly* (DD 929) and the USS *DeWert* (FFG 45) were the Second Fleet ships employed in the tests.

At-sea testing was made possible by the support of Commander in Chief, U.S. Atlantic Fleet (CINCLANTFLT) N6 Capt. D. Owen (since retired), and N62 Cdr. Donald Pacetti.

The NCCOSC In-Service Engineering East Coast Division (NISE East) St. Inigoes detachment provided LAMPS Mark III support with laboratory facilities and personnel whose skills and enthusiasm were crucial to the success of this effort. NISE East also played a vital role in supporting the at-sea testing.

Early system investigations concluded that a host of formidable obstacles stood in the way of achieving a shipboard HDR LOS communications capability. These obstacles caused uncertainty as to the feasibility of creating a practical, operational system using traditional system engineering approaches. Development costs required to implement a new system were expected to be very high and not in line with Department of Defense efforts to reduce research and development budgets. A new approach was needed that operated in the proper super-high-frequency band and was based on a reengineered system already onboard Navy ships.

The LAMPS Mark III system was identified as a prime candidate for the reengineering effort. This system is installed on about 80 Navy ships and uses a helicopter SH60B radio that operates at about 100 nautical miles (nmi) from its mother ship. From this range, the helicopter transmits antisubmarine warfare and antiship surveillance and targeting data at HDR to the LAMPS ship for processing.

The HDR LAMPS communication concept is based on the benefits of a new operational scenario in which the helicopter LAMPS Radio Terminal Set (RTS) ARQ-44 is removed and integrated in the existing shipboard LAMPS III RTS SRQ-4 on the mother ship.

With an integration of the ARQ-4 RTS and ARQ-44 RTS at the radio frequency level, each ship would then have a HDR receive and transmit capability. This change takes the system closer to a full-duplex HDR LAMPS Mark III communication system. Additional modifications have been implemented to achieve the full-duplex communication capability.

For the laboratory and fleet tests, the HDR system actually used spare airborne LAMPS ARQ-44 RTS assets. This was very convenient for the demonstration of HDR ship-to-ship communication link performance. In an operational version of this HDR shipboard system a redesigned, simpler HDR RTS would be used in place of the helicopter LAMPS Mark III ARQ-44 RTS.

The system uses a personal computer-based control and data interface system in the HDR transmit-and-receive paths. The monitors allow a display of transmit-and-receive test patterns and received bit-error count in large data file transfers. Graphic file transfers are also displayed. This system functioned perfectly in the laboratory when operating at its file transfer data rate of 3.1 Mbps. A second data rate of 4.0 Mbps can also be achieved but has not been implemented.

Prior to performing the at-sea HDR LOS communication testing, it was necessary to validate the system for CINCLANTFLT as ready to be installed aboard two Second Fleet ships. The validation was completed at the NISE East LAMPS test laboratories on 17 February.

At-sea testing started and ended on 1 March. Two days of tests were originally scheduled, but 22-foot sea conditions forced a cancellation of the second test day. During the full-duplex portion of the test, which lasted 41 minutes, 7.6 billion bits were exchanged in each direction between the USS *Conolly* and the USS *DeWert* without a single bit error at the 3.1 Mbps rate out to a 13 nmi ship separation.

Because of the rough sea conditions and expected discontinuance of the test, the operators on the USS *Conolly* switched from the original omni to high-gain antenna configuration to a final high-gain to high-gain antenna configuration. The reception on the USS *DeWert*, when totalled over the 169-minute test period, was 31 million bits of data without a single bit being received in error. The data rate was 3.1 Mbps over this entire period, out to a range separation of 22 nmi.

The analysis of the received data suggests that, if the storm had not interfered with the testing, the maximum range separation configuration, even in the omni to high-gain antenna, would have significantly exceeded a LOS range of about 23 nmi before data errors would have been noteworthy.

A second series of HDR LAMPS Mark III communications tests is scheduled to start in early April during fleet exercises. The Second Fleet flagship, USS *Mount Whitney* (LCC 20), will carry as HDR LAMPS Mark III communications system installation in a specially constructed shelter on the main deck. It was necessary to create this shelter because the flagship has no LAMPS Mark III SRQ-4 system on board. The other HDR LAMPS Mark III ship in the test is the USS *Conolly*.

These tests will perform large data file transfers. Using the T1 data interface, created by NRaD personnel, videoteleconferencing and multimedia testing will also be performed over a combined LAMPS/satellite communications path.

HDR LAMPS MARK III COMMUNICATION SYSTEM SHIP-TO-SHIP ENCRYPTED VIDEO TELECONFERENCING

A demonstration of the HDR Mark II proved this system's additional capability for operating at the commercial T-1 data rate of 1.544 Mbps. This represented another historic first in U.S. Navy ship-to-ship communications. This demonstration was geared to multimedia use. Because of the CINCLANTFLT N-6 interest, particular emphasis was placed on the demonstration of ship-to-ship LOS video teleconferencing (VTC). Two VTC systems were actually used simultaneously in ship-to- ship VTC at the 128 Kbps rate: the Picturetel and the Compression Laboratories Incorporated coder/decoder systems.

The recent VTC demonstration was also in the Atlantic, and the HDR LAMPS Mark III Communication System was employed to create LOS links between the Second Fleet flagship USS *Mount Whitney* (LCC 20), and the USS *Conolly* (DD 979). The demonstration was performed during a 7.5-hour test period on Saturday, 16 April.

To conduct the at-sea demonstration of the VTC, it was necessary to create T-1 full duplex data links between two ships that would operate at

1.544 Mbps. This capability resulted from a data interface created by NRaD engineers.

During the at-sea testing, no data errors were detected on the T-1 links by the Fireberd communication link tester. This held true for ship separation ranges up to 20 nmi when the USS *Conolly* was not maneuvering.

During a 5-hour test period, the VTC was received with excellent video quality on each ship. This test required only 128 Kbps of the full T-1 capacity to support a VTC channel. The VTC rate still allowed an acceptable viewer quality relative to subject motion. The VTC could have operated at the full T-1 rate if top commercial quality had been desired.

When operating at the 128 Kbps VTC rate, the balance of the T-1 capacity (i.e., 1.416 Mbps) was normally used by the Fireberd for link testing to determine the bit-error rate (BER) of this segment. The test started at a 15-nmi ship separation and went out to 20 nmi. Testing was limited beyond this range because in the last 1.5 hours of testing poor ship orientation occurred. This caused ship structure to create blockage of the link's LOS radio frequency (RF) signal path.

Occasionally one of the HDR system's four phone lines, POT (plain old telephone system) employing 64 Kbps voice channels, was used over the HDR LAMPS link. Operational voice communications between the ships then occurred simultaneously with VTC operation.

The planning for the foregoing test had to address the fact that the USS *Mount Whitney* does not have a LAMPS Mark III RTS system on board. This communication system had to be provided by installing the components in a specially built shelter.

This new shelter was designed to be installed on the main deck of the USS *Mount Whitney*. The integration of the HDR system into the new shelter was performed by NCCOSC In-Service Engineering East Coast Division (NISE East). When completed it was trucked to Norfolk, VA and hoisted by sea crane onto the USS *Mount Whitney*. The shelter was installed on the ship on the rear port side of the main deck near the Miser tower. It was secured by using the deck built-in helicopter tie-down anchor points.

Since 400-Hz, 115-volt electrical power was not easily available to the shelter from the ship, and was needed for the installed LAMPS Mark III ARQ-44 airborne RTS, a power converter and transformer were also procured and integrated into the shelter. This feature makes the sheltered system much more usable for a variety of other applications, such as operations from a beach. In the USS *Mount Whitney* application, low-loss coax was used as the RF conduit between the HDR transmitter and receiver in the shelter and the omni antenna mounted about 5 feet above the top of the Miser tower.

The USS *Conolly* used the LAMPS Mark III high gain directional antenna mounted high up the mast at about 100 feet above the waterline, protected by a radome. When supporting the HDR communications mode, this antenna automatically tracks the USS *Mount Whitney* omni antenna in azimuth to maintain the RF communication link.

HF AUTOMATIC LINK ESTABLISHMENT (ALE)

ALE Tests. NRaD participated with National Telecommunications Information Administration (NTIA) personnel in over-the-air HF Automatic Link Establishment (ALE) tests in support of National Communication Systems (NCS) compatibility test.

GTE CRADA

NRaD conducted a successful Video Teleconference (VTC) demonstration between NRaD, San Diego and GTE, Needham, MA. The VTC link was established via satellite with ATM switches at both terminals. As part of the GTE CRADA First Experiment, various voice, video, and data applications were demonstrated over a DS3 link operating at 44.7 Mbps.

(IC)2

NRaD participated in a successful demonstration of the (IC)2 at Wallops Island. NRaD was respon-

sible for the backbone network and the administrative network.

HF STANDARDS

NRaD supported over-the-air tests of FED-STD-1052 proof-of-concept developmental modems. These modems are identical to the MIL-STD-188-110A single-tone serial modems but also incorporate powerful ARQ algorithms for error-free data delivery.

LINK-16 TRAINING

NRaD provided Link-16 Communications Planning Training to Fleet Combat Training Center Atlantic instructor personnel. NRaD provided developmental training support on JTIDS through OPEVAL and was tasked with developing computer-based training for multilink operations.

LINK-16

NRaD provided changes to Link-16 Network 11 loads to support video exchange between submarines and surface ships. The modified links were successfully tested aboard the USS *Minneapolis/St. Paul* (SSN 708) and USS *Ticonderoga* (CG 47).

VVFD DEMONSTRATION

NRaD demonstrated the ICE Voice, Fax, and Data (VVFD) over full-duplex HF radios at 4800 baud. A full-duplex 9600-baud link will be completed and will incorporate a code-combining processor to allow 9600-baud full-duplex connectivity between ships for various data applications.

NAVY EHF SATCOM PROGRAM (NESP) STU-III

NRaD supported the NESP STU-III link with the USS *Coronado* (AGF 11). This link provides direct dial from the ship into the telephone system via the EHF package on Fleetsat.

HF COMMUNICATIONS DEMONSTRATION

NRaD established a two-ISB full-duplex HF link supporting 9600 bps between two NRaD buildings. This link was used to demonstrate operation of code-combining ARQ packet software. Error-free throughputs of 2000 to 8100 bps for large files (300 kbits) were demonstrated.

DEMONSTRATION OF UAV TARGET DATA

NRaD successfully passed imagery to our Fleet Imagery Satellite Terminal (FIST) terminal, forecasting successful transfer of UAV target data and imagery from a UAV to NTCS-A, and sharing of that data with other subscribers in the Navy's UHF satellite network.

NAVAL EHF COMMUNICATIONS CONTROLLER (NECC)

NRaD successfully demonstrated NECC. The demonstration used two subscribers (JOTS and CCMail) and one resource (EHF SATCOM). Three sites were used: NRaD, NISE West Vallejo, and Petersen AFB. A gateway functionality was also demonstrated by having electronic mail sent from Petersen AFB to NRaD via a "gateway" (using CCMail automatic forwarding) at NISE West Vallejo.

MILSTAR SATELLITE

NRaD launched the Milstar satellite. Since the down link is passive, NRaD acquired the downlink (on agile). With permission, NRaD acquired the uplink (earth coverage uplink/agile downlink and tactical agile high hop rate). We talked with the Air Force via ANDVT on point-to-point calls.

ELECTRO-OPTIC ELECTROMAGNETIC ENVIRONMENT MONITORING SYSTEMS (EO-EME)

NRaD completed (with NISE West) Phase I in-port testing of an NRaD-developed EO-EME monitoring system aboard USS *Rushmore* (LSD 47). The prototype system is based on EM field induced modulation of a laser signal coupled to an interferometric waveguide modulator. Tests indicate that a single probe, mounted near the mast, can detect and classify emissions from every topside emitter.

CIRCUIT MAYFLOWER (CMF) PHASE I SHORE AUTOMATION

NRaD successfully installed Master Workstation Version 1.1 and made hardware modifications to

the local-area network at the DMF Northwest, VA.

JOINT AIR DEFENSE OPERATION/JOINT ENGAGEMENT ZONE (JADO/JEZ)

NRaD supported HADO/JEZ near-land testing. Provided additional training in Link-16 terminal initialization and operation to support the combined Navy, Air Force, Army, and Marine multi-data link operations.

NATO INTEROPERABLE SUBMARINE BROADCAST SYSTEM (NISBS)

Program accomplishments in CY 94 included the following:

NISBS NCS HE Holt. Successfully completed installation and testing at NCS HE Holt, Australia. The site is now operational, and the RAN channel of information is completely independent from U.S. channels.

NISBS Puerto Rico. Successfully installed and tested NISBS at Naval Radiating Station Aguada, Puerto Rico. NRaD delivered NISBS Software Version 2.2 software, provided training, and participated in site validation testing and training. Messages were generated in CONUS, transmitted to Puerto Rico, and retransmitted VLF and OFF-THE-AIR monitored back in CONUS. The site is now operational. The site can retransmit three channels of U.S. information and one channel of NATO STANAG 5030 information simultaneously.

TOPSIDE ANTENNA PLACEMENT

NRaD obtained an accurate numerical wire grid model—a first in the numerical modeling history of the past 20 years. The model was created with the beta version of the NEEDS 3.0 workstation developed at NRaD to calculate antenna-to-antenna coupling. The PC 1 numerical wire grid model, consisting of 1600 elements, was extracted from a 3–D solid drawing.

SHIP/SHORE CONNECTIVITY

NRaD supported COMNAVSURFPAC and COMDESRON 33 with the installation of a fiber-optic local-area network (LAN) on USS *Rentz* (FFG 46) and subsequent wide-area network (WAN) demonstrations. The LAN will enable the ship to be a learning site in port or underway. The LAN is the medium for transfer of documents, training, maintenance information, and remote medical expertise aboard ship. Multimedia voice, data, and video teleconferencing (VTC) was demonstrated from the ship (in port) via a fiber-optic WAN to COMDESRON 33 headquarters and then to several VTC sites connected to the Defense Commercial Telecommunications Network (DCTN).

TACTICAL TCP/IP

NRaD successfully demonstrated a Tactical TCP/IP WAN using the Red Backbone Architecture. This multilevel security WAN is being used as the communications backbone for most of the Navy JWID demonstrations. The Common Tactical Picture was demonstrated successfully.

MULTIMISSION ANTENNAS

NRaD successfully demonstrated an optically switched dipole antenna. The optically controlled switches were indium phosphide depletion mode JFETs with the gates being controlled by a photovoltaic cell. The required light power to perform switching is only 1 mW, which is considerably less than the unrealistic 500 mW for comparable photo-conductive switches. This antenna could serve as the "unit cell" of a phased-array antenna supporting multiple radiation bands.

OPTOELECTRONICS

NRaD demonstrated a reconfigurable antenna using optically activated field-effect transistors as the switching elements. A single antenna was shown to resonate at two different frequencies in the range from 4 to 6 GHz when an optical signal was directed onto the photo-activated switches. This program is expected to result in a significant reduction in the size, weight, and cost of multifrequency shipboard antenna systems.

INDEPENDENT RESEARCH (IR)

New and innovative ideas proposed by NRaD scientists and engineers are supported and encouraged by the Executive Director through the use of discretionary funding provided by the Independent Research (IR) and Independent Exploratory Development (IED) programs. These programs support initial research and development in many areas of interest to the Navy, including command control, communications, ocean surveillance, and navigation.

Impulse Radio Characteristics at VHF Frequencies. Developed equipment for the investigation of impulse radio characteristics at VHF frequencies.

Tidal Dispersion Mechanisms. Developed a one-dimensional scaling model of enhanced dispersion mechanisms and conducted experiments in San Diego Bay to test the model.

Matched-Field Tracking. Developed a matched-field tracking algorithm for shallow-water acoustic applications.

Logic of Generalizations and Exceptions. Constructed a logic of generalizations and exceptions based on Ernest Adams' logic of conditionals and a heuristic principle.

Variability in HF Propagation Parameters. Obtained a variability index, based on HF data taken in San Diego, which describes the degree of variability to be expected in HF propagation parameters.

Wavelets for Ultrabroadband Radar. Formulated a general theory for the inversion of discrete non-orthogonal wavelets. Developed Morlet wavelet analysis software and applied it to ultra-broadband radar data.

Large Sparse Systems of Equations. Developed a new algorithm for solving sets of linear equations involving sparse, structurally symmetric matrices that compares favorably to the best methods currently in use.

Adaptive Equalization for High-Data-Rate Communications. Obtained and evaluated adaptive blind equalization algorithms used in suppressing intersymbol and other additive interference in high-data-rate communications applications.

Standard Colorimetry Equations for Color Mixing. Showed that the standard color mixing equations lose accuracy when dealing with highly saturated laser light in the red or blue.

Optical Ringing in Marine Water. Demonstrated a possible link between optical ringing and the excess light that is often seen in underwater LIDAR measurements.

APPENDICES

APPENDIX A

CIVILIAN AWARDS

LETTERS OF APPRECIATION FROM THE PRESIDENT

Jeff Haun
Dr. Eric Hendricks
Dr. Jim Rohr
For contributions to the Technology Reinvestment Project

DoD, NAVY AWARDS

Secretary of Defense Award for Excellence

Dr. Robert Smillie for service on a one-year assignment as Assistant Director of the Defense Modeling and Simulation Office.

Advanced Research Projects Agency Director's Award

Norm Ortwein for exceptional leadership and management skills on the Micro-Global Positioning Satellite Program, the High-Speed A/D Converter Program and the Ultra Electronics Program.

Navy Distinguished Civilian Service Award

Jerry Beauchane for exceptional efforts in direct fleet support, including service as the first coordinator of the Navy Science Assistance Program (NSAP); efforts as NSAP science advisor to Commander, Second Fleet and Commander, Naval Surface Force, Pacific; and playing an essential role in development of afloat and ashore command and control capabilities for operational forces.

Navy Superior Civilian Service Award

Ref Delgado for service as Navy Science Assistance Program science advisor to Commander, Middle Eastern Force/U.S. Naval Forces, Central Command, specifically in his extraordinary technical contributions to C^4I capabilities during operations Southern Watch and Continue Hope.

Earl Towson for extraordinary leadership and managerial competence in diversified areas of Navy research and development as head of the Command's Technical Planning Staff.

Dr. Sachio Yamamoto for contributions to the Navy's science and technology interests in Asia and the Pacific through service as Director of Office of Naval Research Asian Office from October 1990 to June 1993.

Navy Meritorious Civilian Service Award

Michael Brininstool for technical leadership and contributions in fiber optics.

Gary Brown for substantial contributions in communication systems engineering, including the Extremely High Frequency (EHF) Communications Controller and the Communications Support System.

John Clark for project management on communication systems and technology development efforts, including installation of communications systems aboard the carriers USS *Nimitz* (CVN 68) and USS *Kitty Hawk* (CV 63).

Cesar Clavell for leadership in environmental efforts, including service

as special assistant to the Deputy Assistant Secretary of the Navy (Installations and Environment).

Ron Crepeau for leadership as chief scientist for the Operations Support System, playing the key role in making it the premier Navy ashore command and control system.

Helen Dae for outstanding service as supervisor of the Travel Office.

Richard Dexter for introduction of the Advanced Combat Direction System Block 1 aboard the carrier USS *Constellation* (CV 64).

Bob Dinger for technical leadership in the surveillance radar field, including substantial contributions to development of a high frequency surface wave radar.

John Ehlers for his significant contributions in development of undersea fiber optic-based deployable array technology, resulting in successful fielding of the Ariadne demonstration.

Dr. Clarence Fuzak for engineering leadership in development of advanced communication systems.

Duane Gomez for his efforts in pioneering use of advanced, low-cost, commercial off-the-shelf displays in future Navy combat direction systems.

Gene Haviland for engineering leadership for several Strategic Systems Project Office projects, including the Mark 9 Trident Missile Test and Readiness Equipment.

Bob Hearn for playing the key role in establishment of the Paragon High Performance Computing facility and strengthening NRaD's leadership position in parallel computing.

Dr. Tom Kaye for efforts as system engineer for the Advanced Deployable System, including leading definition of missions, requirements and architecture.

Robin Laird for leadership as program manager of the Mobile Detection Assessment Response System.

Paul Leupold, who managed the Vertical Launch ASROC program from engineering development to fleet introduction, providing the Navy an effective, low-cost, extended range antisubmarine warfare capability.

Charles Merrow for technical and analytical oversight of surveillance programs and strategic planning of future undersea surveillance and air defense initiatives.

Lou Naglak for technical contributions to the Navy and a wide array of other federal agencies, particularly the National Oceanic and Atmospheric Administration and the Navy's Special Projects Office, and for his leadership of the NRaD Navigation and Air C^3 Department.

Jim Rahilly for efforts as principal investigator in development of a high data rate communications link, including conceiving and developing use of an existing ASW system for high data rate line of sight communications.

Nathan Schatz for work as data engineer for the Joint Maritime Command Information System, resulting in implementation of a command and control system capable of presenting real-time tactical data in modern joint operations.

Alice Smith for substantial support in establishment of the NCCOSC In-Service Engineering East Coast Division and bringing 120 NISE East employees into the Demonstration Project.

Rod Smith for leadership and technical oversight of preparations for technical evaluation of the new tactical data link,

Link 16, including preparations for deployment on the USS *Carl Vinson* carrier battle group.

Ty Wernet for technical contributions and leadership in transforming the industrial funding accounting system into the NCCOSC Finance and Accounting System.

Candice Wilson for managing high-quality personnel services for NRaD and NISE East which followed introduction of the Demonstration Project at NISE East.

Dr. Carl Zeisse for outstanding contributions in materials research and development of semiconductor devices, and for his recent contributions in atmospheric physics.

Navy Award of Merit for Group Achievement

Advanced Deployable Array

Jim Price
Leslie Shumway
Jill Bekkedahl
Randy Brannan
Lynn Collins
Dana Cottrell
John Ehlers
Chance Geurin
Lucille Glancy
Dave Hannum
Mark Hogue
James Kaawaloa
Paul Kennedy
David Miranda
Richard Myers
John Olson
Patrick Osborne
Todd Pickering
Alan Sczepaniak
Willie Stevenson
Lynne Tablewski
Todd Webber
Jesus Zuniga
Jack Zyphur

Cost Savings Process Action Team

Mary Butterbrodt
Bettye Boley
William Ehrie
Tom Enderwick
Violet Forbes
Charles Francis
Fe Goleta
Sue Hager
Robert Lematta
Charlie Morrin
Elaine Qualy
Ervin Schutt
Roseann Steinhardt

Defense Conversion Payroll System Changeover

Candida Alvarez
John Barhoum
Marva Bragg
Mary Buseck
Guadalupe Castro
Robert Cooper
Marie Dahlheim
Cecile Fix
Lois Frigerio
Doug Hamaguchi
Tina Horn
J. R. Islas
Corky Larson
Sandra Low
Kathleen Mancuso
Charlotte Moseley
Paula Murset
Katherine Ross
Charles Rutherford
David Smith
David Stevens
Rose Valderrama
Teresa Weisbecker
Candice Wilson

Travel Office Staff

Helen Dae
Tom Krieger
Jacki Robinett
Sharon Roe

Special Act Award

James Logan for contributions to definition and development of the

Advanced Enclosed Mast/Sensors System concept.

Excellence in Science Award

John Kammerer, presented by Commander, Naval Surface Force Pacific for his contributions to that command during this 3-year tour as a Navy Science Assistance Program science advisor.

ASSOCIATION AWARDS

Institute of Electrical and Electronic Engineers (IEEE) Fellow

Dr. James Zeidler

American Defense Preparedness Association Special Achievement Award

Larry Arndt for his work in undersea surveillance signal processing

Supercomputing 94 Hetergeneous Computing Challenge First Place

NRaD Heterogeneous Computing Team

Popular Mechanics Magazine Design and Engineering Award

Laser-Based 3–D Volumetric Display

MILITARY AWARDS

Navy Achievement Medal

BMC Doreen Dower, USN, for superior performance as Craftmaster of Torpedo Weapons Retriever 823 and of Research Craft IX-508.

BM2 Anthony Grizzle, USN, for superior performance as Craftmaster of Torpedo Retriever Boat 4 and for service on the NCCOSC Commander's staff.

Captain William Van Bonn, USA, for superior performance of duties as Army veterinarian attached to the Marine Mammal Program at NRaD, including playing an instrumental role in advancing forward deployment capabilities in Operation Bell Thunder '93.

MM1 (DV) Randy Marker, USN
EN1 (DV) Christian Wells, USN
EN2 (DV) Gregory Dickson, USN
For superior performance in providing diving support to locate, identify and repair damaged Southern California Offshore Acoustic Range cables at Sam Clemente Island.

OSCM Harry Ozmun
EWC Mark Wyrick
OS1 Tyrone Henson
OS1 Scott Mocabe
OS2 Howard Asbury
For service as program analysts and instructors for the Advanced Combat Direction System Block 1 program, providing installation, test and evaluation of the system on board USS *Constellation* (CV 64).

Good Conduct Medal

RM2 Sabrina Jeter
OS1 Scott Mocabe

NRaD AWARDS

Lauritsen-Bennett Award

Peter Comstock
Dr. Stephen Lieberman
Robert Stephenson

Executive Director Award

Jerry Beauchane for outstanding contributions in the area of direct fleet support, including service as Navy Science Assistance Program coordinator and science advisor for Second Fleet and Naval Surface Force, Pacific.

Publication Awards

Terence Albert
Elaine Allen
Paul Baxley
Jill Bekkedahl
Dr. Ike Bendall
Dr. Richard Bocker

Dr. James Bond
Dr. Randall Brill
Wallace Bryan
Dr. Adi Bulsara
Dr. George Chen
Ward Davies
Charles Deneris
Timothy Dowd
Gerald Edwards
William Friedl
Janice Garrett
Dr. Irwin Goodman
Jesse Goycochea
Dr. Peder Hansen
Dr. Frank Hanson
Maria Hermanson
Todd Hintz
Susan Hutchins
Everett Jacobs
Mary Jenner
Laura Knight
Dr. David Lambert
David Law
David Lowenstein
Gerald Mackelburg
Ronald Nelson
Hien Nguyen
Dr. Richard North
Peter Poirier
John Rockway
Robert Rose
David Sailors
Craig Sayre
Gabor Schmera
James Schukantz
Dr. Mark Shensa
Robert Slack
David Steber
Dr. David Stein
Phillip Steinweg
Anthony Sterrett
Patricia Talley
Loyd Terpening
Chiang Tom
Ronald Tong
Richard Uhrich
Dr. Maniel Vineberg
James Walton
Timothy Warren
Stan Watson
Dr. James Zeidler

NRaD Sailor of the Year

OT(A)1 Timothy Hirtle

Secretarial Awards

Sharon Gossam
Patsy Hildebrandt

Service Awards

45 Years

Donald Davis
John Hardesty
James Thomson

APPENDIX B

PATENT AWARDS
CY 94

Inventor(s)	Title	Patent No.	Date
Everett, Hobart R., Jr.	Doorway Transit Navigational Referencing System	5,276,618	4 Jan 94
Bullat, David M. Bradshaw, Philip C. Brown, Jay C.	Acoustic Window	5,276,658	4 Jan 94
Scheps, Richard	Multifrequency, Rapidly Sequenced or Simultaneous Tunable Laser	5,276,695	4 Jan 94
Haber, William J.	Buffered Feedthrough Crossbar Switch	5, 278,548	11 Jan 94
Scheps, Richard	Compact, Efficient, Scalable Neodymium Laser Co-Doped with Activator Ions and Pumped by Visible Laser Diodes	5,285,467	8 Feb 94
Schlosser, Thomas W.	Combiner for Two Dimensional Adaptive Interference Suppression System	5,289,194	22 Feb 94
Shimabukuro, Randy L. Wood, Michael E. Csanadi, Oswald I.	Method for Fabricating Complementary Enhancement and Depletion Mode Field Effect Transistors on a Single Substrate	5,300,443	5 Apr 94
Geller, Myer	Multi-Channel, Covert, Non-Line-of-Sight UV Communication	5,301,051	5 Apr 94
Hitney, Herbert V.	High Speed Method for Predicting Radio-Wave Propagation	5,301,127	5 Apr 94
Cronyn, Willard M.	Uninterrupted, Enhanced-Rate Event Sequencer with Mixed-Speed Counter Modules	5,301,219	5 Apr 94
Shimabukuro, Randy L. Russell, Stephen D.	Multilayer Microelectronic Photomultiplier Device with a Stacked Series of Dynode and Insulating Layers	5,306,904	26 Apr 94
Scheps, Richard	Wavelength Dispersive Gain Element for a Tunable Laser	5,307,358	26 Apr 94
Everett, Hobart R., Jr. Gilbreath, Gary A.	Reflexive Teleoperated Control System for a Remotely Controlled Vehicle	5,307,271	26 Apr 94
Everett, Hobart R., Jr. Nieusma, Judy M.	Feedback System for Remotely Operated Vehicles	5,309,140	3 May 94
Russell, Stephen D. Sexton, Douglas A.	Method of Laser Processing Ferroelectric Materials	5,310,990	10 May 94
Russell, Stephen D. Sexton, Douglas A. Orazi, Richard J.	Method for Laser-Assisted Etching of III-V and II-VI Semiconductor Compounds Using Chlorofluorocarbon Ambients	5,310,989	10 May 94

Inventor(s)	Title	Patent No.	Date
Apitz, Sabine E. Lieberman, Stephen H.	Method for Quantitative Calibration of In Situ Optical Chemical Measurements in Soils Using Soil Class and Characteristics	5,316,950	31 May 894
Russell, Stephen D. Sexton, Douglas A. Kelley, Eugene P.	Laser Texturing	5,322,988	21 Jun 94
Kelly, Eugene P. Russell, Stephen D. Sexton, Douglas A.	Method of Rapid Sample Handling for Laser Processing	5,323,013	21 Jun 94
Tran, Trung H.	5-Volt Low Level Serial Transceiver	5,325,395	28 Jun 94
Lewis, Gregory Ryan-Jones, David L.	Method and/or System for Personal Identification and Impairment Assessment from Brain Activity Patterns	5,325,862	5 Jul 94
Hitney, Herbert V.	Method and System for Inferring the Radio Refractive Index Structure of the Atmosphere from Radio Measurements	5,327,359	5 Jul 94
Jones, Thomas E. McGinnis, Wayne C. Briggs, J. Scott	Compact Substrate Heater for Use in an Oxidizing Atmosphere	5,329,097	12 Jul 94
Hammond, Russell E. Johnson, Leopold J.	Hybrid High Power Amplifier	5,329,245	12 Jul 94
Kamikawa, Neil T. Nakagawa, Arthur T.	Pure-Silica Core Dual-Mode Optical Fiber	5,329,607	12 Jul 94
Shimabukuro, Randy L. Russell, Stephen D.	Method of Fabricating a Microelectronic Photomultiplier Device with Integrated Circuitry	5,329,110	12 Jul 94
Dubbelday, Wadad B. Flesner, Larry D. Imthurn, George P.	Method of Forming a High Voltage Silicon-On-Sapphire Photocell Array	5,330,918	19 Jul 94
Sexton, Douglas A.	Microdynamic Devices Fabricated on Silicon-On-Sapphire Substrates	5,331,236	19 Jul 94
Scheps, Richard	Technique for Intracavity Sum Frequency Generation	5,333,142	26 Jul 94
Zirino, Albert	Control of Continuous Phase pH Using Visible Light to Activate pH-Dependent Fibers and Gels in a Controlled and Reversible Manner	5,334,629	2 Aug 94
Kirkpatrick, Thomas I.	High Isolation Electronic Switch	5,334,881	2 Aug 84
Jones, Thomas E. McGinnis, Wayne C.	Method for Determining the Granular Nature of Superconductors Using Pulsed Current	5,339,025	16 Aug 94
McLandrich, Matthew N. Albares, Donald J. Pappert, Stephen A.	Method for Characterization of Optical Waveguide Devices Using Partial Coherence Interferometry	5,341,205	23 Aug 94
Wescott, Thomas F. McCleary, Lawrence E.	Selective Polygon Map Display Method	5,341,463	23 Aug 94
Gadbois, Laurence E.	Storm Water Runoff First Flush Sampler	5,347,877	20 Sep 94

Inventor(s)	Title	Patent No.	Date
Russell, Stephen D. Sexton, Douglas A. Orazi, Richard J.	Method for Laser-Assisted Silicon Etching Using Halocarbon Ambients	5,348,609	20 Sep 94
Whiteside, Steven K.	Flow Tripped Injector	5,351,889	4 Oct 94
Rubin, David Reinke, Kurt	Transition from Double-Ridge Waveguide to Suspended Substrate	5,361,049	1 Nov 94
Russell, Stephen D. Sexton, Douglas A.	Laser Controlled Decomposition of Chlorofluorocarbons	5,362,450	8 Nov 94
Cartagena, Eric N.	Method for Fabricating Vertical Bipolar Junction Transistors in Silicon Bonded to an Insulator	5,362,659	8 Nov 94
Cavanaugh, David B. Goldberg, Warren M.	Versatile Digital Recording System for Recording High Resolution Video Imagery	5,363,264	8 Nov 94
Shimabukuro, Randy L. Russell, Stephen D.	Microelectronic Photomultiplier Device with Integrated Circuitry	5,264,693	23 Nov 93

APPENDIX C

DISTINGUISHED VISITORS 1994

JANUARY

4 Jan: Dr. Barry Horton, Principal Deputy Assistant Secretary of Defense for Command, Control, Communications and Intelligence

Rear Admiral Leonard Oden, USN, Head, Customer Services Division, Office of the Director of Space and Electronic Warfare (N61), Office of the Chief of Naval Operations

13 Jan: Rear Admiral Kenneth Fisher, USNR, Deputy Commander, Naval Air Force, U.S. Atlantic Fleet

Mr. Tim Peterson, Ms. Julie Pacquing, Professional Staff Members, House Appropriations Committee Defense Subcommittee, U.S. House of Representatives

FEBRUARY

2 Feb: Mr. Peter Dorn, Professional Staff Member, Select Committee on Intelligence, U.S. Senate

7 Feb: Rear Admiral Lewis Felton, USN, Director, Communications Systems Directorate (PD 50), Space and Naval Warfare Systems Command

10 Feb: Rear Admiral (Select) Patrick Moneymaker, USN, Director,, Command and Control Warfare Division (N64), Office of the Chief of Naval Operations

14 Feb: Dr. John A. Fannon, Director, General Surface Weapons (Naval), Ministry of Defence, United Kingdom

22–25 Feb: Brigadier General Ibrahim El-Bohy, Deputy Department Head, Tactical Software Development Center, Egypt

25 Feb: Rear Admiral John Hekman, USN, Commander, Naval Information Systems Management Center

Rear Admiral Geoffrey Chesbrough, USN, Oceanographer of the Navy, Office of the Chief of Naval Operations

Admiral James R. Hogg, USN (Ret.), National President, National Security Industrial Association

28–1 Mar: Rear Admiral Wesley Jordan, USN, Deputy Director, Space and Electronic Warfare (N6B), Office of the Chief of Naval Operations

MARCH

1 Mar: Mr. Dennis Marquis, Director, Technical Center, Supreme Headquarters, Allied Powers Europe (SHAPE), The Hague, Netherlands

2 Mar: Rear Admiral Dennis Vaughan, USN, Deputy/Vice Commander, Naval Surface Forces, U.S. Pacific Fleet

Rear Admiral (Select) Dennis Conley, USN, Deputy Director, Expeditionary Warfare Division (N85B), Office of the Chief of Naval Operations

Rear Admiral Thomas Paulsen, USN, Deputy Director, Naval Training and Doctrine (N7B), Office of the Chief of Naval Operations

Rear Admiral Philip Dur, USN, Director, Strategy and Policy Division (N51), Office of the Chief of Naval Operations

Rear Admiral Ernest Christensen, USN, Commander, Fleet Air Caribbean

Rear Admiral William Putnam, USN, Executive Assistant, Commander-in-Chief, U.S. Atlantic Fleet

Rear Admiral (Select) James Eastwood, USN, Commander, Military Sealift Command, Atlantic

2–3 Mar: Rear Admiral Dennis Conley, USN, Deputy Director, Expeditionary Warfare Division (N85B), Office of the Chief of Naval Operations

3 Mar: Major General David Kelley, USA, Vice Director, Command, Control, Communications & Computer Systems, The Joint Staff

Dr. Ed Whitman, Technical Director, Office of the Oceanographer of the Navy

17 Mar: Ms. Valerie Wallick, Executive Director, Information Technology Acquisition Center

21 Mar: Dr. John Silva, Director, Office of Naval Research, Europe

Dr. Vic Rehn, Director, Office of Naval Research, Asia

22 Mar: Honorable Nora Slatkin, Assistant Secretary of the Navy (Research, Development and Acquisition), Office of the Secretary of the Navy

Rear Admiral David Oliver, USN, Deputy for Resources, Analysis and Policy

Vice Admiral Robert Spane, USN, Commander, Naval Air Force, U.S. Pacific Fleet

Vice Admiral David Robinson, USN, Commander, Naval Surface Force, U.S. Pacific Fleet

Rear Admiral Marc Pelaez, USN, Chief of Naval Research

Rear Admiral Edward Sheafer, Jr., USN, Director of Naval Intelligence, Office of the Chief of Naval Operations

Rear Admiral Raymond Smith, Jr., USN, Commander, Naval Special Warfare Command

Rear Admiral Wesley Jordan, Jr., USN, Acting Director, Space and Electronic Warfare (N6), Office of the Chief of Naval Operations

Rear Admiral John Ryan, USN, Commander, Task Force 12/Commander, Patrol Wings, U.S. Pacific Fleet

Rear Admiral James Fitzgerald, USN, Deputy and Chief of Staff, Commander-in-Chief, U.S. Pacific Fleet

Rear Admiral Jon Barr, USN, Commander, Submarine Force, U.S. Pacific Fleet

Rear Admiral Raymond Jones, USN, Chief, Naval Technical Training

Rear Admiral Thomas Ryan, USN, Director, Submarine Warfare Division, Office of the Chief of Naval Operations

22–23 Mar: Mr. Ed Zdankiewicz, Deputy Assistant Secretary of the Navy (Mine/Undersea Warfare)

23 Mar: Brigadier General Geoffrey Higginbotham, USMC, Commanding General, First Force Service Support Group, Headquarters and Service Battalion, Marine Corps Base Camp Pendleton

APRIL

1 Apr: Admiral Jacques Grossi, Director, Directorate of Naval Construction, Ministry of Defense, France

4 Apr: Brigadier General Ramadan Mowed, Software Manager, Armament Division, Eqyptian Air Force

Brigadier General Mahmoud Hola Mohamed, Deputy Department Head, Research and Development Software Center, Eqypt

5 Apr: Professor De Sen Yang, Acoustical Engineering Institute of Harbin, Shipbuilding Engineering Institute, People's Republic of China

19 Apr: Ms. Deborah Castleman, Deputy Assistant Secretary of Defense for

Command, Control and Communications

21 Apr: Rear Admiral (Select) Patrick D. Moneymaker, USN, Director, C^4 Warfare Division (N64), Office of the Chief of Naval Operations

MAY

9–11 May: Rear Admiral Lewis A. Felton, USN, Director, Communication Systems, Information Transfer Systems Directorate (PD 50), Space and Naval Warfare Systems Command

12 May: Lieutenant General Paul Yvan De Saint Germain, Director, Research and Technology, Direction des Recherches Etudes el Techniques, Ministry of Defense, France

Major General Gerard La Rose, Assistant Director

20 May: Rear Admiral John Zerr, USN, Commander, Operational Test and Evaluation Force

JUNE

2 Jun: Honorable Anita Jones, Director, Research and Engineering, Office of the Secretary of Defense

13–14 Jun: Mr. Robert W. Lautrup, Mr. Richard Helmer, Professional Staff Members, Surveys and Investigation Staff, U.S. House of Representatives

15 Jun: Rear Admiral James Amerault, USN, Director, Operations Division, Office of Budget Reports, Navy Comptroller's Office

15 Jun: Major General Phillip Bracher, USAF, Director, Command Control Systems and Logistics (J4/J6), United States Space Command/Director, Communications-Computer Systems, Air Force Space Command

21 Jun: Brigadier General Russell H. Sutton, USMC, Commanding General, Marine Corps Air Ground Combat Center

30 Jun: 1994 Naval National Science Award Winners

JULY

6–7 Jul: Rear Admiral David M. Altwegg, USN (Ret.), Deputy Program Executive Officer, Theatre Air Defense

13 Jul: Rear Admiral John Zerr, USN, Commander, Operational Test and Evaluation Force

14 Jul: Vice Admiral Arthur Cebrowski, USN, Director, Space and Electronic Warfare (N6), Office of the Chief of Naval Operations

18–29 Jul: Rear Admiral Marc Pelaez, USN, Chief of Naval Research

Dr. James Colvard, Chairman, Naval Research Advisory Committee

19 Jul: Rear Admiral James Fitzgerald, USN, Deputy and Chief of Staff, Commander-in-Chief, U.S. Pacific Fleet

Rear Admiral Lee Gunn, USN, Comander, Amphibious Group Three

26 Jul: Rear Admiral Frederick Lewis, USN, Commander, Naval Doctrine Command

AUGUST

1–2 Aug: Rear Admiral Walter Cantrell, USN, Commander, Space and Naval Warfare Systems Command

3–4 Aug: Rear Admiral Lewis Felton, USN, Director, Communication Systems, Information Transfer Systems Directorate (PD 50), Space and Naval Warfare Systems Command

8 Aug: Major General Carol A. Mutter, USMC, Commanding General, Marine Corps Systems Command

11 Aug: Rear Admiral Walter Davis, USN, Director, Naval Warfare System Architecture and Engineering Directorate (SPAWAR 30), Space and Naval Warfare Systems Command

17–18 Aug: Rear Admiral Patrick D. Moneymaker, USN, Director, Command, Control, Communications, Computer

and Intelligence (C^4I) Systems, U.S. Strategic Command

18 Aug: Professor Sir David Davies CBE, FRS, FEng, Chief Scientific Advisor, Ministry of Defence, United Kingdom

31 Aug: Brigadier General Leslie Palm, USMC, Commanding General, Marine Corps Air Ground Combat Center

SEPTEMBER

6–8 Sep: Dr. John Silva, Director, Office of Naval Research, Europe

12 Sep: Rear Admiral Dennis A. Jones, USN, Commander, Submarine Group Eight/Prospective Director, Submarine Warfare Division (N87), Office of the Chief of Naval Operations

14–15 Sep: Rear Admiral Thomas Ryan, USN, Director, Submarine Warfare Division (N87)/Prospective Director, Test and Evaluation and Technology Requirements Division (N91), Office of the Chief of Naval Operations

19–20 Sep: Dr. John Silva, Director, Office of Naval Research, Europe

OCTOBER

24 Oct: Major General Paul Van Riper, USMC, Assistant Chief of Staff, Command, Control, Communications, Computers and Intelligence, Headquarters Marine Corps

NOVEMBER

1 Nov: Lieutenant General Anthony C. Zinni, USMC, Commanding General, First Marine Expeditionary Force

Major General Paul Fratarangelo, USMC, Commanding General, Third Marine Air Wing

2 Nov: Dr. Paris Genalis, Deputy Director, Naval Warfare (Acquisition and Technology), Office of the Secretary of Defense

14 Nov: Rear Admiral Richard D. Williams, III, USN, Program Executive Officer for Mine Warfare, Office of the Assistant Secretary of the Navy (Research, Development and Acquisition)

Major General James M. Myatt, USMC, Director, Expeditionary Warfare (N85), Office of the Chief of Naval Operations

Rear Admiral Dennis R. Conley, USN, Deputy Director

17–18 Nov: Dr. Marv Langston, Deputy Assistant Secretary of the Navy for C^4I, Space and Electronic Warfare, Office of the Assistant Secretary of the Navy (Research, Development and Acquisition)

18 Nov: Professor Lui Pao Chen, Chief Defense Scientist, Assistant Professor Su Guaning, Director, Defense Science Organization, Ministry of Defense, Singapore

DECEMBER

5–12 Dec: Brigadier General Aly Safwat Salah El-Din, Chief, Egyptian Air Force Software R&D Center

6 Dec: Vice Admiral Walter Davis, Jr., USN, Director, Space and Electronic Warfare (N6), Office of the Chief of Naval Operations

14 Dec: Vice Admiral Conrad Lautenbacher, Jr., USN, Commander, Third Fleeet

20 Dec: Rear Admiral Richard A. Buchanan, USN, Commander, Submarine Group Two

28 Dec: Dr. Marv Langston, Deputy Assistant Secretary of the Navy for C^4I Space and Electronic Warfare, Office of the Assistant Secretary of the Navy (Research, Development and Acquisition)

APPENDIX D

MAJOR CONFERENCES AND MEETINGS 1994

JANUARY

10–14 Jan: Joint Air Tasking Conference

13–14 Jan: Next Generation Computer Resources High Performance Network Working Group

18–21 Jan: NATO Identification System Joint Experts Group Working Group Meeting

19 Jan: ICEX '94 Meeting

FEBRUARY

1–3 Feb: Software Engineering Institute Advisory Board Meeting

15 Feb: National Technology Transfer Center Seminar on Navy Technology Marketing Tools

15–16 Feb: Secure Survivable Communications Network Meeting

15–17 Feb: The Technical Cooperation Program Asynchronous Transfer Mode Meeting

17 Feb: West Coast Senior Executive Service Meeting

28 Feb – 4 Mar: Undersea Warfare Program Conference

MARCH

22–23 Mar: National Security Industrial Association 34th Undersea Warfare in Joint Regional Conflicts Conference

22–24 Mar: Naval Air Systems Command Software Engineering Working Group Meeting

APRIL

5–6 Apr: Global Positioning System West Coast Users Conference

13 Apr: Center for the Control of Fluids Workshop

13–15 Apr: Research Study Group 12 on Non-Cooperative Air Target Identification

20–22 Apr: NRaD/Armed Forces Communications and Electronics Association Joint C^4I Symposium

25–29 Apr: Joint Maritime Command Information Systems Requirements Working Group

MAY

11–12 May: Combat Survivor Evader Locator Joint Users Conference

JUNE

6–10 Jun: Communications Systems Network Interoperability Technical Coordination Group Meeting

13 Jun: San Diego Super Computer Center Consortium Executive Committee Meeting

14 Jun: Library of Congress Special K Workshop

20–23 Jun: The Technical Cooperation Program

29 Jun: ICEX-94 Hot Washup Meeting

JULY

11–14 Jul: American Institute of Aeronautics and Astronautics/Ballistic Missile Defense Organization (AIAA/BMDO) Interceptor Technology Conference

18–20 Jul: Department of Defense High Performance Computing Modernization Program Meeting

18–29 Jul: Naval Research Advisory Committee (NRAC) 1994 Summer Study

20 Jul: 1994 Summer Computer Simulation Conference on Advancing Simulation Capabilities Tour

AUGUST

2–3 Aug: Army Interface Working Group Meeting

8–12 Aug: Naval Intelligence Security Awareness Committee Security Educators Seminar

22 Aug – 1 Sep: Joint Warrior Interoperability Demonstration

30 Aug – 1 Sep: Software Engineering Institute Capability Maturity Model Training Class

SEPTEMBER

19–23 Sep: The Technical Cooperation Program Subgroup K Working Group Panel

20–22 Sep: TRAP/TADIXS B Users Working Group Conference

26–29 Sep: United States/Australian Joint Study Group Meeting on Over-The-Horizon Radar Research and Development

28 Sep: Regional Transportation Technology Alliance Meeting

OCTOBER

3–7 Oct: The Technical Cooperation Program Subgroup X Meeting

4–6 Oct: Naval Simulation System Meeting

5–7 Oct: NATO E-3A Mod Block 1/U.S. Navy/U.S. Air Force Interoperability Demonstration Technical Interface Meeting

25–27 Oct: Submarine Command, Control, Communications, Computers and Intelligence Working Group Meeting

26 Oct: High Frequency Surface Wave Radar Conference

NOVEMBER

1 Nov: 65th Shock and Vibration Symposium

1–3 Nov: The Technical Cooperation Program Neural Network Workshop

8 Nov: Government Microcircuit Application Conference '94

15–16 Nov: Advanced Torpedo Mark 46/Vertical Launch ASROC Planning Meeting

15–17 Nov: Electro Optics Propagation Assessment in Coastal Environments Workshop

17–18 Nov: Direct Broadcast Satellite Demonstration

DECEMBER

5–8 Dec: Biosonar Workshop

6–8 Dec: Capabilities Assessment Expert System Fleet Project Team Meeting

7–8 Dec: Command, Control, Communications, Computers and Intelligence Systems Directorate Technical Interchange Meeting

12–16 Dec: ASW Activity Modeling Workshop

12–16 Dec: Deployable Surveillance Workshop

ACRONYMS

ACRONYMS

A

ACDS Advanced Combat Direction System
ADI Air Defense Initiative
ADS Advanced Deployable System
AFWTF Atlantic Fleet Weapons Test Facility
AG Application Gateway
AIC Atlantic Intelligence Center
AIU Advanced Interface Unit
ALE Automatic Link Establishment
ANN Artificial Neural Network
ARPA Advanced Research Projects Agency
AWACS Aircraft Warning and Control System

B

BBS Brigade/Battalion Battle Simulation
BCA Broadcast Control Authorities
BER Bit-Error Rate
BMD Ballistic Missile Defense
BMDO Ballistic Missile Defense Organization

C

C^2P Command and Control Processor
C^3I Command, Control, Communications, and Intelligence
C^4I Command, Control, Communications, Computers, and Intelligence
CCDs Charged-Coupled Devices
CDBS Central Data Base Server
CDC Combat Direction Center
CDNU Control Display Navigation Unit
CDS Combat Direction System
CEC Cooperative Engagement Capability
CINCLANTFLT Commander in Chief, U.S. Atlantic Fleet
CMSA Cruise Missile Support Activity
CO Commanding Officer
COMARFORPAC Commander Marine Forces Pacific
COMNAVAIRPAC Commander, Naval Air Forces Pacific
COTS Commercial Off-the-Shelf
CRADA Cooperative Research and Development Agreement
CTAPS Contingency Theater Automated Planning System
CUB Cryptologic Unified Build
CWC Composite Warfare Commander
CY Calendar Year

D

DAMA Demand-Assigned Multiple-Access
DCTN Defense Commercial Telecommunications Network
DIS Distributed Interactive Simulation
DRS Data Refinement System
DSI Defense Simulation Internet
DSVC Dam Neck Validation Center
DTD Data Terminal Device

E

EDFA Erbium-Doped Fiber Amplifiers
EDM Engineering Development Model
EHF Extremely High Frequency
EMC Electromagnetic Compatibility
ESGN Electrically Suspended Gyro Navigator

F

FCC Fleet Command Center
FCTCLANT Fleet Combat Training Center Atlantic
FIST Fleet Imagery Satellite Terminal
FMOCC Fleet Mobile Operational Command Center
FMS Foreign Military Sales
FY Fiscal Year

G

GAT Government Acceptance Test
GCCS Global Command and Control System
GPS Global Positioning System
GPSIU Global Positioning System Interface Unit
GSF Gaming and Simulation Facility

H

HARM High-Speed Anti-Radiation Missile
HBT Heterojunction Bipolar Transistor
HDR High-Data-Rate
HF High-Frequency
HyDy Highly Dynamic

I

IED Independent Exploratory Development
IFF Identification, Friend or Foe

InGaA	Indium Gallium Arsenide
INSURV	Inspection and Survey
InP	Indium Phosphide
I/O	Input/Output
IR	Independent Research
ISEA	In-Service Engineering Agent
ISFET	Ion-Sensitive Field-Effect Transistor
IUSS	Integrated Undersea Surveillance System
IV&V	Independent Validation and Verification

J

JDISS	Joint Deployable Intelligence Support System
JICPAC	Joint Intelligence Center Pacific
JMCIS	Joint Maritime Command Information System
JPO	Joint Program Office
JRI	JOTS-ROTHR Interface
JTIDS	Joint Tactical Information Distribution System

K

KELT	Korean/English Language Translator
KMS	Key Management System

L

LAN	Local Area Network
LFA	Low Frequency Active
LLSS	Low-Level Serial Switch
LOS	Line-of-sight
LPO	Link Project Office

M

MAPTIP	Marine Aerosol Properties Thermal Imager Performance
MAST	Mobile Ashore Support Terminal
MATT	Multimission Advanced Tactical Terminal
MBE	Molecular Beam Epitaxy
Mbps	Million Bits Per Second
MCAS	Marine Corps Air Station
MCAPS	Mission Control and Processing Subsystem
MCB	Marine Corps Base
MDARS	Mobile Detection, Assessment, and Response System
MerWatch	Merchant Watch
MIPRs	Military Interdepartmental Purchase Requests
MLP	Multilayer Perceptron
MMATS	Marine Mammal Acoustic Tracking System
MMRT	Missile Motor Railcar Transporter
MMS	Marine Mammal Systems
MODSAF	Modular Semi-Automated Forces
MPEDS	Multiplatform Emulator Device System
MPL	Marine Physical Laboratory
MTWS	MAGTF Tactical Warfare Simulation

N

NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
NAVSSI	Navigation Sensor System Interface
NCCOSC	Naval Command, Control and Ocean Surveillance Center
NCS	National Communication Systems
NDI	Nondevelopmental Item
NISE East	NCCOSC In-Service Engineering East Coast Division
NISE West	NCCOSC In-Service Engineering West Coast Division
NM	Nanometers
NMCC	National Military Command Center
NMFS	National Marine Fisheries Service
NMI	Nautical Miles
NOC	Network Operations Center
NRT	Near Real Time
NSAP	Navy Science Assistance Program
NTCS-A	Navy Tactical Command System-Afloat
NTDS	Navy Tactical Data System

O

OCNR	Office of the Chief of Naval Research
OIC	Operational Intelligence Center
OMVPE	Organometallic Vapor Phase Expitaxial
ONI	Office of Naval Intelligence
OPTEVFOR	Operational Technical Evaluation Force
OPEVAL	Operational evaluation
OSP	Ocean Survey Program
OTC	Officer In Tactical Command
OTCIXS	Officer-in-Tactical Command Information Exchange Subsystem
OTH-T	Over-the-horizon Targeting

P

PAS	Port Area Surveillance
PDU	Protocol Data Unit
PEOSCS	Program Executive Officer-Space, Communications and Sensors
PET	Pilot-Line Experimental Technology
PINC	Polarization Independent Narrow
PLARS	Position Locating and Reporting System
POL	Petroleum, Oil, and Lubricant Channel
PWC	Public Works Center

Q

QE Quantum Efficiency

R

RADCON Radio Controller
RCP Requests for Contractual Procurement
RESA Research, Evaluation, and Systems Analysis
RF Radio Frequency
RIC Radar Intercept Officer
RLGN Ring Laser Gyro Navigator
RNUS Range NTDS Upgrade System
ROTHR Relocatable Over-the-Horizon Radar
R.O.K. Republic of Korea
RTS Radio Terminal Set

S

SAIT Science Applications International Technology
SAS System Analysis Station
SAT System Acceptance Test
SCAPS Site Characterization and Analysis Penetrometer System
SCORE/SURF SIGINT Universal Recognition Facility
SCS Survey Control System
SEAF STOW-E Engineering and Analysis Facility
SIF System Integration Facility
SIL Systems Integration Laboratory
SIMNET Simulation Network
SLAM Standoff Land Attack Missile
SOSUS Sound Surveillance Underwater System
SOF-IV Special Operating Forces-Intelligence Van
SPAWAR Space and Naval Warfare Systems Command
SSA Software Support Activity
SSIXS Submarine Satellite Information Exchange Subsystem
STIC Surveillance Test and Integration Center
STOW Synthetic Theater of War
STOW-E Synthetic Theater of War-Europe
STSS Surveillance Towed-Array Sensor System
STTS Shipboard Tracking and Telemetry System
SWELLEX Shallow-water Evaluation Cell Experiment
SWS Shallow-water Sensor SystemS

T

TACTS Tactical Air Combat Training Systems
TADIL-J Tactical Digital Information Link-J
TADILs Tactical Digital Information Links
TADIXS Tactical Data Information Exchange Subsystem
TARIF Tactical Air Range Instrumentation Facility
TDA Technical Development Agent
TDA Technical Direction Agent
TDP Tactical Data Processors
TDPCON Tactical Data Processor Controller
TFSOS Thin-Film Silicon on Sapphire
TGFs TADIXS Gateway Facilities
TGP TADIXS Gateway Processor
TRE Tactical Receive Equipment
TRAP Tactical Related Applications
TSCM Tomahawk Strike Coordination Module

U

UFL Ulchi Focus Lens

V

VME Versa Module Eurocard
VTC Video Teleconference
VVFD Voice, Fax, and Data

W

WAN Wide Area Network
WDM Wavelength Division Multiplexing
WES Waterways Experiment Station
WSS Waterside Security System

INDEX OF TECHNICAL PROGRAMS AND MAJOR TOPICS

INDEX OF TECHNICAL PROGRAMS AND MAJOR TOPICS

A

B

C

D

E

F

G

H

I

J

U

V

W

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